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Augmenting yield in chickpea through cluster front line demonstrations on pulses in Shivpuri district of Madhya Pradesh, India

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Abstract
Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops in Shivpuri and Bundelkhand region of India including districts of Madhya Pradesh and Uttar Pradesh. One of the major constraints of traditional chickpea farming is low productivity due to non-adoption of improved technologies. To boost the production and productivity of pulse crops, Krishi Vigyan Kendra Shivpuri is conducting cluster frontline demonstrations (CFLDs) on pulse crops. The main objective of CFLD on pulses is to demonstrate and popularize the improved technologies on farmers' fields for effective transfer of generated technology and fill the gap between recommended practices and farmers' practices and ultimately to boost the production of pulses. Frontline demonstrations in chickpea during rabi season were studied for five years (Rabi 2016-17, Rabi 2017-18, Rabi 2018-19, Rabi 2019-20 and Rabi 2020-21) in Shivpuri district of Madhya Pradesh. There was a wide yield gap between the potential and demonstration yields mainly due to technology and extension gaps. CFLD on chickpea crop indicated that increase in yield over farmers' practice ranged from 25.22 to 47.32% over five years. In terms of economics, chickpea crop recorded higher net returns per hectare compared to farmer's practice during all the years. The B: C ratio of demonstration plots ranged from 2.86 to 4.41. The technology index varied from 9.00 to 44.04% indicating the urgent need to motivate the farmers to adopt economical viable technologies for increasing production, productivity and profitability of chickpea.

Keywords: Chickpea, B: C ratio, yield, yield gap, potential yield, technology index

Introduction

Chickpea (*Cicer arietinum* L.) also known as Bengal gram or gram is one of the important grain legumes of the world which is grown in 44 countries across five continents. India is the largest producer of chickpea accounting to 75 per cent of world production. The major chickpea growing states in India are Madhya Pradesh, Uttar Pradesh, Maharashtra, Andhra Pradesh, Bihar, Karnataka, Rajasthan, and Gujarat. Being a leguminous and hardy crop, chickpea does very well under dry tracts, which receive an annual rainfall of 60-100 cm. It grows on a very light sandy loam to heavy textured clay soil (Poonia *et al.* 2020) [11]. Chickpea has been known in this country for long time. Chickpea ranks third in world production among peas and beans. It accounts 31.77 per cent of the area and 45.70 per cent of production in India (Pichad *et al.* 2014) [12].

Pulses play important role in Indian agricultural economy next to food grains and oilseeds in terms of acreage, production and economic value (Choudhary, 2009) [2]. Pulse production in India has fluctuated widely leading to steady decline in the per capita availability over last 20 years (Gregory *et al*., 2003) [4]. In India, pulses are grown on an area of 9.85 million hectare with an annual production of 11.99 million tonnes and productivity of 1217 kg per ha (GOI, 2020-21). The productivity of pulses in Madhya Pradesh has been improving for last ten years and now it has crossed the national average however production is low compared to some states. Thus, there is enough opportunity as well as challenge for policy makers, farm scientists, extension functionaries and farming community to enhance pulse productivity and diversify their cropping systems to meet out the national and local pulse requirements.

Shivpuri district of Madya Pradesh is situated at approximately 25.43^0 North latitude and 77.65^0 East longitude with an elevation of 468 meters amsl.

Chickpea (*Cicer arietinum*), black gram (*Vigna mungo*), and lentil (Lens esculenta) are the three main pulse crops grown by the farmers of the district. The productivity of pulses in the district is low compared to national and global average, mainly due to their cultivation under rainfed and marginal lands besides poor crop management practices (Choudhary, 2009) [2]. Besides this, lack of technical knowledge, unavailability of quality seed and non-adoption of integrated plant protection measures further aggravate the problem of poor productivity in the district. There exists a wide yield gap in between the experimental plots, frontline demonstrations plots and farmer fields.

Raj *et al* (2013) [13] reported the yield of chickpea can be increased up to 113.25% (1480 Kg/ha) with adoption of improved technologies such as improved variety, recommended dose of fertilizer, weed management and plant production.

Taking into account the above facts, present investigation was undertaken to demonstrate and transfer the generated farm technology through CFLD on pulses under semi-irrigated production systems with the objectives of enhancing productivity, profitability and narrowing extension yield gaps. Technological and extension yield gaps under pulses in this comprehensive study are also presented in this paper for framing appropriate extension strategy for effective transfer of technology to target farmers in the district and collateral socio-economic environments for improving the pulse production systems.

Material and Methods

The present study was carried out by the Krishi Vigyan Kendra, Shivpuri, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya Gwalior (Madhya Pradesh) in *Rabi* seasons in the farmers' field of 24 -villages of Shivpuri district in Gird-Bundelkhand agro-climatic zone of Madhya Pradesh during 2016-17 to 2020-21 in semi-irrigated condition on light to medium soils with low to medium fertility status under soybean-chickpea production system. Each demonstration was conducted in an area of 0.4 ha and 0.4 ha area adjacent to the demonstration plot as farmer's practices *i.e.*, prevailing cultivation practices served as local check. All 500-front line demonstrations in 200 ha area were conducted in 24-different villages. The improved technologies package included chickpea wilt resistant varieties, line sowing, integrated nutrient management and integrated pest management. The varieties of chickpea JG 130 (bold seeded and wilt resistant) in 2016-17 and 2017-18 and RVG-202 (bold seeded and resistant to wilt) in 2018-19, 2019-20 and 2020-21 were included in demonstrations. The spacing was at 30x10 cm and sowing done during 15 October to 31 October every year with a seed rate of 75 kg/ha. Farm manure/ vermicompost @ 5 ton/ha and entire dose of Nitrogen and Phosphorus through di-ammonium phosphate, and potash through muriate of potash @ 20:60:25 kg/ha, respectively was applied before sowing as basal. The seeds were treated with *Trichoderma viride* @ 5g/kg seed then inoculated by liquid *Rhizobium* and *Phosphosolubilizing bacteria* bio-fertilizers each 5ml/kg of seeds+ pheromone traps for *Helicoverpa armigera and Spodoptera litura* @ 02/plot + bird perches (T shaped pegs) @ 10/plot was applied. Hand weeding was done once at 35-days after of sowing. The crop was harvested during 1 March to 15 March.

In demonstration plots, critical inputs in the form of quality seed and seed treatment, vermicompost, liquid Rhizobium and PSB, Pheromone traps and Bird perches were provided by KVK and remaining inputs were applied by the farmers as per suggestions given by KVK. For the study, technology gap, extension gap and technology index were calculated as suggested by Samui *et al*. (2000) [16].

Technology gap = Potential yield - Demonstration yield

Extension gap =Demonstration yield – Farmers' yield

Technology index (%) = Technology gap / Potential yield x 100

Results and Discussion

Seed Yield

The productivity of chickpea of demonstrations (under improved production technologies) ranged from 12.00 to 24.50 q/ha with highest average yield 22.54 q/ha. In the cultivation of chickpea under improved technologies, the productivity ranged from 15.50 to 20.00, 13.60 to 18.00, 16.50 to 22.50, 19.50 to 24.50 and 12.00 to 16.50 q/ha with an average yield of 18.20, 16.50, 19.80, 22.54 and 13.99 q/ha during 2016-17, 2017-18, 2018-19, 2019-20 and 2020-21, respectively (Table-1) as against yield ranged 9.50 to 18.00 with a mean of 13.64 q/ha recorded under farmer's practices (Local check). The additional yield under improved technologies over local check ranged from 3.70 to 5.30 q/ha with a mean of 4.57q/ha. In comparison to local check there was an increase of 25.52, 47.32, 32.00, 47.26 and 37.46% in productivity of improved technologies in respective years. The increased grain yield with improved technologies was mainly because of line sowing, use of improved wilt resistant varieties, integrated nutrient management, timely weed management and integrated pest management. Bunyamin and Walley (2013) [1] reported that adoption of chickpea varieties produced 62% higher yields. Poonia *et al* (2011) [10], reported 21.1% increased yield in FLDs over local varieties. Nazrul Islam *et al* (2004) [9] recorded 35% in black gram compared to local varieties. Singh *et al* (1999) [17] obtained increased (9%) grain yield of black gram due to line sowing (30x10cm) over broadcasting method of sowing. Tomar (1998) [20] and Tomar *et al.* (2009) [19] reported that the application of balanced fertilizers (20:60:20 NPK kg/ha) along with PSB increased yield of black gram by 97% over no fertilizer application. Hand weeding once at 25 days after sowing produced 57% more yield over no weeding (Yadav and Shrivastava 1998) [21].

Table 1: Seed yield of chickpea as affected by improved and local practices in farmers' fields

Year	Varieties	Area (ha)	Demons. (Nos.)	Potential yield (q/ha)	Yield of Demo (Improved technology) (q/ha)			Local check avg. (q/ha)	Extension gap (q/ha)	% Increase in yield over Local check	Technology gap (q/ha)	Technology index (%)
					Max.	Min.	Avg.					
2016-17	JG 130	20	50	20	20.0	15.5	18.20	14.5	3.7	25.52	1.8	9.00
2017-18	JG 130	20	50	20	18.5	13.6	16.50	11.2	5.3	47.32	3.5	17.50
2018-19	RVG 202	20	50	25	22.5	16.5	19.80	15.0	4.8	32.00	5.2	20.80
2019-20	RVG 202	20	50	25	24.5	19.5	22.54	18.0	4.54	25.22	2.5	9.84

2020-21	RVG 202	20	50	25	16.5	12.0	13.99	9.5	4.49	47.26	11.0	44.04
Average		20	50	23	20.4	15.42	18.21	13.64	4.57	35.46	4.8	20.24

Table 2: Cost of Cultivation (Rs/ha), net return (Rs/ha) and Benefit: Cost-ratio of as affected by improved and local practices

Year	Cost of cultivation		Gross return		Net return		Additional cost of cultivation	Additional net return	Benefit Cost ratio (B:C Ratio)	
	Demo	Check	Demo	Check	Demo	Check			Demo	Check
2016-17	23000	22000	83720	62100	60720	40100	1000	20620	3.64	2.82
2017-18	30000	28000	85800	58240	55800	30240	2000	25560	2.86	2.08
2018-19	25686	25000	93795	69300	68109	44300	686	23809	3.65	2.77
2019-20	25164	24000	110904	89550	85740	65550	1164	20190	4.41	3.73
2020-21	25600	24000	69950	47500	44350	23500	1600	20850	2.73	1.98
Average	25890.00	24600.00	88833.80	65338.00	62943.80	40738.00	1290.00	22205.80	3.46	2.68

Average yield (2016-17 to 2020-21)

The average productivity of chickpea under demonstrations (18.21 q/ha) was much higher than the average yield of farmers practices (13.64 q/ha). The average percentage increased in the yield over farmer's practices was 35.46%. The results indicated that the front-line demonstrations have given a good impact over the farming community of Shivpuri district as they were motivated by the new agricultural technologies applied in the FLD plots (Table 1). This finding is in corroboration with the findings of Poonia and Pithia (2011) [10], Raj *et al*. (2013) [13] and Singh *et al.* (2013) [18].

Economic performance

The economic performance of improved technologies over traditional farmers' practices was calculated depending on prevailing prices of inputs and outputs costs (Table-2). It was found that cost of production of chickpea varied from Rs.23000 to 30000/ha with an average of Rs.25890/ha of improved technologies as against the variation in cost of production from Rs. 22000 to 28000/ha with an average of Rs.24600/ha in local check. The improved production technologies registered an additional cost of production ranging from Rs. 686 to 2000/ha with a mean of Rs. 1290/ha over local check. The additional cost incurred in the improved technologies as compared to farmers' practices was mainly due to more costs involved in balanced fertilization, improved seed, seed treatment and weed management practices. Cultivation of chickpea under improved technologies gave higher net return ranged from Rs. 44350 to 85740/ha, with a mean value of Rs. 62943.80/ha as compared to local check which recorded Rs.23500 to 65550/ha with a mean of Rs. 40738/ha. There was an additional net return of Rs. 20620 in 2016-17, 25560 in 2017-18, 23809 in 2018-19, 20190 in 2019-20 and 20850 in 2020-21 per ha under demonstration plots. The improved technologies also gave higher benefit cost ratio 3.64, 2.86, 3.65, 4.41 and 2.73 compared to 2.82, 2.08, 2.77, 3.73 and 1.98 under local check in the corresponding seasons. This may be due to higher yields obtained under improved technologies compared to local check (farmers practice). This finding is in corroboration with the findings of Mokidue *et al*, (2011) [7] and Singh *et al.* (2013) [18]. The results from the current study clearly brought out the potential of improved production technologies in enhancing chickpea production and economic gains in semi-irrigated condition of Shivpuri district of Madhya Pradesh.

Technology gap

The technology gap in the demonstration of chick pea yields over potential yield ranged from 1.80 to 11.00 q/ha with an average of 3.85 q/ha over the period of five years (Table 1). The technological gap may be attributed to the dissimilarity in the soil fertility status and weather conditions (Mukharjee, 2003) [8].

Extension gap

The highest extension gap of 5.30 q/ha was recorded in chickpea variety JG-130 and the lowest was observed in 3.70 q/ha in the same variety. This 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 accordance with the findings of Hiremath and Nagaraju (2010) [5] and Singh *et al* (2013) [18].

Technology Index

The technology index shows the feasibility of the evolved technology at the farmers' fields and the lower the value of technology index more is the feasibility of the technology (Jeengar, *et al*., 2006) [6]. The average technology index was 20.24 per cent, while 44.04% maximum technology index was during 2020-21 but lowest 9.00% was during 2016-17 (Table 1).

Reason of Low Yield of Pluses at Farmers' Field:

Non-availability of quality seed for sowing at optimum time, lack of awareness for seed treatment, no integrated approach for weed, insects and disease control and unavailability of improved and disease resistant varieties are some of the common causes of low productivity. Very less popularization of seed cum fertilizer drill for sowing and use of inadequate and imbalance dose of fertilizers especially the nitrogenous and phosphate fertilizers by farmers also does not make possible to fetch potential yield. Timely weed control practice not adopted due to unawareness about chemical weed control and costly labour and mechanical weed control. Lack of knowledge of integrated pest management (IPM) also is one of the major reasons to not reaching near potential yield at farmers' fields.

Conclusion

The yield of chickpea crop can be increased to a greater extent and yield gaps may be minimised by adopting the recommended package of practices and improved technology in Shivpuri district of Madhya Pradesh. Favourable benefit-cost ratio (B: C Ratio) is self-explanatory of economic viability of the frontline demonstrations and encouraged the farmers for adoption of interventions imparted. The higher extension gap emphasized that there is further need to educate the farmers for adoption of improved technologies so that poor farmers with limited resources could improve their livelihood and diversify their farming situation. Hence, by adopting improved technologies of chick pea, 25 to 47% additional yield and 20000 to 25000 rupees additional net return per ha can be achieved.

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