RESEARCH ARTICLE Agricultural Science Digest, Volume 41 Issue 1: 66-70 (March 2021)

Performance Assessment of Cluster Front Line Demonstrations in Chickpea (*Cicer arietinum* L.) for Productivity Enhancement under Rainfed *Vertisols* of YSR District Andhra Pradesh

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ABSTRACT

Cluster FLDs were organized by Krishi Vigyan Kendra, Utukur in *rabi* bengalgram during three consecutive years of 2013-14, 2014-15 and 2015-16 under rainfed *vertisols* farming situation in an area of 52 ha. at 94 locations. At every demonstration site improved management practices *viz.* improved variety with high yield potential and drought tolerance (Nandyal sanaga-1), Compartmental bunding (8 m x 5m), Soil test based integrated balanced nutrition: sulphur granules @ 10 kg ha^{-1}, zinc sulphate @ 20 kg ha^{-1} as basal, biofertilizers like *rhizobium*, *PSB* and *KSB* @ 5 kg ha^{-1} by incubating in 100 kg of farm yard manure under shade for 15 days, Seed treatment of *Trichoderma viride* @ 5g $kg^{-1}$of seed 7. Integrated Pest Management strategies like erection of pheromone traps 20 no. per ha., spraying of NSKE@ 0.5%, bird perches @ 30 no. Per ha and spraying need based pesticides for management of *gram pod borer* were demonstrated against existing farmers practice of bengalgram cultivation. The bengalgram yields under demonstration practice higher than farmers practice in all the three years. The per cent increase in yield over farmers practice is lowest (5.8 per cent) during 2013-14 and highest (20.9 per cent) during 2015-16 with an average increase of 15 per cent observed in demonstration practice. The average gross returns of three years is Rs. 51533/- per hectare in demo practice, which is 15.5 per cent higher than the farmer's practice (Rs.44626 per ha). The net returns of Rs.19173/- per ha was recorded under demonstration practice and it was 259 per cent higher than the farmer's practice (Rs.7393/- per ha). The mean benefit cost ratio of three years of demonstration package higher (1.58) than farmers practice (1.20).

Key words: Balanced nutrition, B:C ratio, Cluster, Front line demonstrations, Integrated pest management.

INTRODUCTION

Cluster frontline demonstration (CFLDs) are demonstrated for the production potential of new technological interventions like new released varieties, biofertilizers, novel chemical formulations, soil test based balanced fertilization, biological pest control measures and mechanization aspects *etc*. on the farmer's fields at a different locations under existing major farming situation/cropping system and organized in cluster manner in which the favourable effect on crop yields will be popularized among farming community and extension workers through field visits, capacity building programmes for the horizontal spread of various technologies. In India, chickpea (*Cicer arietinum* L.) is the major food legume with an area, production and productivity of 9.93 M ha, 9.53 M tonnes and 960 kg ha^{-1} respectively (Anonymous, 2014). The states like Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka and Andhra Pradesh together contributed to 91% of the production and 90% of the area (Singh *et al.*, 2015). The existing productivity of chickpea is very low (779 kg ha^{-1}) due to various reasons like crop raised on marginal and sub marginal soils with low fertility status, low yield potential of existing varieties, lack of awareness among growers on INM and IPM practices, moisture stress at critical stages of crop growth period and severity of gram pod borer etc. In order to address these production constraints and harnessing the sustainable yields, National Food Security Mission (NFSM), Pulses has launched with objectives of restoring soil fertility and productivity at individual farm level, creation of employment opportunities, enhancing farm level economy to restore confidence among the farmers and creating awareness about the use of improved seed and crop Production technology by Indian Council of Agricultural Research (ICAR) and Indian Institute of Pulse Research (IIPR) through Krishi Vigyan Kendra's (KVK's) at district level with 100 per cent financial assistance by Ministry of Agriculture, GOI. Under this programme, new technological interventions like 1) improved Seed: distribution of Certified

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How to cite this article: Mohan, M.M., Ramalakshmi, D.S, Srinivasulu, D.V. and Veeraiah, A. (2021). Performance Assessment of Cluster Front Line Demonstrations in Chickpea (*Cicer arietinum* L.) for Productivity Enhancement under Rainfed *Vertisols* of YSR District Andhra Pradesh. Agricultural Science Digest. 41(1): 66-70. DOI: 10.18805/ag.D-5136.

Submitted: 20-01-2020 **Accepted:** 01-05-2020 **Online:** 22-08-2020

seed, 2) Integrated Nutrient Management (INM): Micronutrients, lime/gypsum, rhizobium and bio-fertilizer cultures, 3) Integrated Pest Management (IPM): Encouraging farmers to adopt mechanical / biological / bio-pesticide practices, 4) Resource Conservation Technologies (RCT's)/tools: Knapsack sprayers, zero till seed drills, multi crop threshers, seed drills, rotavators and laser land levellers and 5) Efficient water application tools: Distribution of sprinkler sets, incentive for mobile sprinkler rain guns, Incentive for pumpsets and Pipes for carrying water from source to the Field during moisture stress situation were demonstrated in farmer's fields against farmer's practice under rainfed black soils.

Rabi chickpea grown in an area of 1.20 lakhs hectares under rainfed *vertisols* farming situation in Y.S.R Kadapa district of Andhra Pradesh with an average productivity of 750 kg ha^{-1} but there is a greater variation among existing productivity and potential productivity of rainfed vertisols of the district. In order to narrowing the gap between existing and potential productivity of chickpea, Best Management Practices (BMP's) recommended by Indian Institute of Pulse Research (IIPR), Kanpur were demonstrated in farmer's fields at strategic locations representing from entire Y.S.R Kadapa district in cluster's approach during 2014-15, 2015-16 and 2016-17 (three years). Under cluster frontline demonstrations scientists of KVK, Utukur demonstrated the critical interventions for higher productivity by providing the critical essential inputs and technical knowhow from time to time during critical crop growth stages.

MATERIALS AND METHODS

Cluster front line demonstrations in chickpea organized by Krishi Vigyan Kendra, Utukur with financial support from ICAR-ATARI- Zone-V during *rabi* season in 2014-15, 2015-16 and 2016-17 in Kamalapuram, Vempalli, Yerraguntla, Pendlimarri, Vallur and C.K.D mandals of Y.S.R. Kadapa district of Andhra Pradesh in an area of 52 ha and 94 farm holding's with average size of 0.4 ha at every demonstration site. The study area falls under semi arid type of climate with average annual rainfall of 710 mm. The south west monsoon (June-Sep), north east monsoon (Oct-Dec) contributes 56.6% 33.6% of annual average rainfall and remaining 9.8% received in rest of months in a year. The temperature ranged between 12.0°C to 47.8°C and the cropping intensity is about 120%, since the maximum area of black soils under mono-cropping of *rabi* chickpea. The KVK scientists conducted preliminary survey in operational area through Participatory Rural Appraisal (PRA) techniques and identified the production constraints for *rabi* chickpea cultivation during summer season (march-june). The majority of the farmers in KVK operational area are cultivating age old *desi* variety *annegiri*, which is having very low yield potential and susceptible to wilt disease. The farmers have habit of applying complex fertilizers like 28-28-0 and 20-20-0 alone without secondary and micro nutrients and that too one to two months prior to the advancement of optimum sowing window by broadcasting method. This practice may leads to the loss of nitrogen through leaching, runoff and volatilization and phosphorous by fixation with clay and calcium compounds, which ultimately results in poor nutrient use efficiency of applied fertilizers. The farmers are also unaware of soil testing procedures and soil test based fertilizer recommendations, which further limiting factors for getting sustainable yields. The farmers not adopting any soil and water conservation measures during *kharif* season leads to runoff and leaching of water along with nutrients, hence the crop frequently experienced to moisture stress at critical stages causing drastic yield decline in most of the cultivated area of chickpea. The selection of participatory farmer's for conducting cluster demonstrations including demo site selection, farmers selection, layout of demonstration, farmers participation etc. were followed (Choudhary.1999). The soil samples were collected at 0-15 cm depth from each demonstration site by random sampling and the samples were processed and confine the sample weight to 500 g by quartering method. The soil samples were analysed for fertility status at Agricultural Research Station, Utukur with duly following the standard procedures. The soils are slightly alkaline in reaction (pH range - 7.9-8.9), slightly saline (0.25-0.75 d Sm^{-1}), organic carbon low to medium (0.32-0.48%), with available nitrogen, phosphorous and potassium ranged between low (60-130 kg ha^{-1}), low to medium (16-50 kg ha^{-1}) and medium to high (140-380 kg ha^{-1}) respectively. The fertilizer recommendation to each demonstration based on soil test data given in Table 1.

At each demonstration site implemented the Best Management Practices (BMP's) *viz.,* 1. Variety with high yield potential and drought tolerance (Nandyal sanaga-1), 2. Compartmental bunding with size of 30 m^2 (8 m x 5m) during *kharif* season for *insitu* rainwater harvesting, 3. Soil test based fertilizer balanced application, 4. Application of sulphur granules @ 10 kg ha^{-1} and zinc sulphate @ 20 kg ha^{-1} as basal dose, 5. Application of biofertilizers like *rhizobium*, *Phosphate Solubilising Bacteria* (*PSB*) and *Potash Solubilising Bacteria* (*KSB*) @ 5 kg ha^{-1} by incubating in 100 kg of farm yard manure under shade for 15 days, 6. Seed treatment of *Trichoderma viride* @ 5g $kg^{-1}$of seed to manage wilt disease, 7. Integrated Pest Management (IPM) strategies for management of *gram pod borer*: Erection of pheromone traps as 20 no's ha^{-1}, spraying of Neem oil (1500 ppm) at 20-30 DAS, erection of bird fetches @ 20 no's ha^{-1} and spraying of pesticides in sequence of low LD 50 to high LD 50 values during crop growth application in chickpea cultivation and the farmer's practice (check) include: Cultivation of local varieties with low yield potential and susceptibility to diseases (*eg*. annegiri): Application of complex fertilizers well in advance of sowing of the crop without secondary and micro nutrient application, No *insitu* rain water conservation practices like compartmental bunding during *kharif*, Indiscriminate spraying of high dose of lethal pesticides (3-4 sprays) against gram pod borer

without adoption of any IPM practices, No seed treatment with chemicals or *T.viride* against wilt disease, No biofertilizers application to supplement the chemical fertilizers. The above mentioned demonstration and farmer's practice of chickpea cultivation were compared for three consecutive years (2013-14, 2014-15 and 2015-16). The crop sown during first F.N of October in all the three years and came to the maturity during second F.N of January and harvested by manual picking followed by mechanical threshing. The method demonstrations conducted on seed treatment with *Trichoderma viride,* multiplication of biofertilizers by FYM incubation method, erection of pheromone traps to the participatory farmer's. The yield data recorded from 5m × 5m plot in demo and farmer' practice separately at each demonstration site and average grain weight taken at 14% moisture and converted into kilogram per hectare (kg ha^{-1}). The field days at harvest were conducted with neighbouring farmers and extension officials for horizontal spread of the technology to other areas at large scale. The yield data, cost of cultivation, gross returns, net returns and B:C ratio of demonstration and farmer's practice were recorded at each location, tabulated and analyzed the data year wise. Further, from the yield obtained from demonstration and farmers method in the study area extension and technology gap were a workout for the study area using following formulae (Samui *et al.,* 2000).

Technology gap = Potential yield - demonstration yield
Extension gap = Demonstration yield - farmer's yield

Technology index =

$$\frac{\text{(Potential yield-demonstration yield)}}{\text{Potential yield}} \times 100$$

% Yield increase =

$$\frac{\text{(Demonstration yield-Farmers practice yield)}}{\text{Farmers practice yield}} \times 100$$

RESULTS AND DISCUSSION

Bengalgram yield

Krishi Vigyan Kendra, Utukur conducted cluster FLDs in *rabi* bengalgram to demonstrate the production potential of new released varieties/technologies during 2013-14, 2014-15 and 2015-16 against farmers practice under rainfed black soil farming system. The yield and economics of both demonstration practice and farmer practice presented in Table 2 and 3. The results indicated that the average gram yield was 1450 kg ha^{-1} (810 kg ha^{-1} to 2100 kg ha^{-1}) and 1370 kg ha^{-1} (750 kg ha^{-1} to 1687 kg ha^{-1}) during *rabi* 2013-14, 1185 kg ha^{-1} (625 kg ha^{-1} to 1750 kg ha^{-1}) and 1002 kg ha^{-1} (550 kg ha^{-1} to 1425 kg ha^{-1}) during *rabi* 2014-15 and 1355 kg ha^{-1} (875 kg ha^{-1} to 1975 kg ha^{-1}) and 1121 kg ha^{-1} (789 kg ha^{-1} to 1550 kg ha^{-1}) in 2015-16 respectively under demonstration practice and farmers practice. The per cent increase in yield under demonstration practice is lowest (5.8 per cent) during 2013-14 and highest (20.9 per cent) during 2015-16 with an average of 15 per cent yield increase observed in demonstration practice over farmers practice. These results are in similarity with results reported by Mohan *et al.,* 2019 in Cluster FLDs in sunflower (Table 2).

The yield data of three consecutive years clearly indicated the positive impact of cluster FLDs over farmers practice towards productivity enhancement of *rabi* bengalgram under rainfed balcksoil farming situation of YSR district and similar results also reported by Poonia and Pithia 2011 in cluster FLDs in bengalgram. The higher yields in demonstrations over farmer's method is mainly due to effective control of gram pod borer by IPM practices which is main responsible for yield reduction in bengalgram, higher *insitu* moisture availability in demonstrations with the practice of compartmental bunding adopted during *kharif* season and soil test based balanced nutrition contributed towards yield increase in demonstrations compared with farmer's practice.

The extension gaps ranged between 80 kg ha^{-1} to 234 kg ha^{-1} during cluster FLDs in bengalgram which emphasized the enhancement of knowledge level of the farmers on improved varieties/agricultural technology innovations to bridge the existing gap through field days, capacity buildings and exposure visits among the neiboring farmers having similar farming situation. The demonstration yield of the three years compared with potential yield of bengalgram and calculated the technology gap and technology index separately. The technology gap ranged between 234 kg ha^{-1} to 550 kg ha^{-1} which further indicates that there is greater scope of productivity enhancement in subsequent years through transfer of best management practices from research station to farmers fields (katare *et al.,* 2011). Whereas the technology index indicates the extent of feasibility of improved technology at farmer level under existing local situations. The technology index of the demonstrations ranged from lowest (27.5 per cent) during 2013-14 to highest (40.7 per cent) during 2014-15 with average technology index of 33.5 per cent. The variations might be attributed to variations in level of soil nutrients, soil moisture availability, incidence of gram pod borer, integrated nutrient, pest and disease management strategies in the study area (Table 2).

Economics of cluster FLDs

The cost incurred during cultivation of bengalgram including land preparation, procurement of critical inputs *viz.* seeds, fertilizers, pesticides *etc.* harvesting and threshing and seed selling price prevailed in that year were considered for computing the cost of cultivation, gross income, net income and benefit cost ratio for demonstration practice and farmers practice separately and presented in Table 3.

From the three years data, the cost to be incurred during cultivation was lowered in demonstration practice against farmers practice in all the three years. On an average Rs.4873 ha^{-1} was saved by demonstration practice mainly by adopting the integrated pest management and soil test based integrated nutrient management practices. All the three years higher gross returns and net returns

Table 1: Fertilizer recommendations to the demonstration sites based on soil test values.

S.No	Nutrient parameter	Range	Fertilizer recommendation based on soil test values
3	Available nitrogen (kg ha^{-1})	60-130 (Low)	25 per cent higher than recommended nitrogen (25 kg ha^{-1}) was applied at basal only.
4	Available Phosphorous (kg ha^{-1})	16-50 (low to medium)	Recommended phosphorous (50 kg ha^{-1}) was applied where soil having medium (22-56 kg/ha) P_2O_5 status, whereas 25% higher than recommended phosphorous (62.5 kg ha^{-1}) applied to soils with low (<22.5 kg ha^{-1}) P_2O_5 content.
5	Available potassium (kg/ha)	140-380 (medium to high)	There is no recommendation of potassic fertilizers to chickpea
6	Available sulphur (ppm)	4.0-12 (low)	Apply 8-10 kg of water soluble sulphur granules at basal
7	Zinc (ppm)	Deficient (<0.6)	Soil application of 20 kg ha^{-1} zinc sulphate at basal and also recommended to spray chelated $ZnSO_4$ @ 0.2% on standing crop whenever the deficiency symptoms occurred.

Table 2: Yield, Extension gap, technology gap and technology index in chickpea under cluster FLDs and farmer method in YSR district, A.P.

	2013-14		2014-15		2015-16	
	Demo practice	Farmer practice	Demo practice	Farmer practice	Demo practice	Farmer practice
Area (ha)	12		20		20	
Number of Demonstrations	30		29		35	
Mean Yield (kg ha^{-1})	1450	1370	1185	1002	1355	1121
S.E m	56.5	42.5	68.5	31.1	50.0	35.9
C.V (%)	25.2	27.5	31.1	29	20.5	17.8
Per centage increase over farmer's practice	5.8		18.3		20.9	
Potential yield (kg ha^{-1})	2000 kg ha^{-1}		2000 kg ha^{-1}		2000 kg ha^{-1}	
Extension gap (kg ha^{-1})	80		183		234	
Technology gap (kg ha^{-1})	550		815		645	
Technology index	27.5		40.7		32.2	

Table 3: Economics of demonstration practice *Vs* farmers' practice of chickpea cultivation.

Year	Cost of cultivation		Gross returns		Net returns		B:C ratio		Additional cost incurred in demo practice	Additional net returns
	Demo practice	Farmers practice	Demo practice	Farmers practice	Demo practice	Farmers practice	Demo practice	Farmers practice		
2013-14	Rs.31582	Rs.33750	Rs.43500	Rs.41100	Rs.11918	Rs.7350	1.38	1.22	(-) Rs. 2,168	(+) Rs. 4,568
2014-15	Rs.31500	Rs.37500	Rs.47401	Rs.40084	Rs.15901	Rs.2584	1.50	1.07	(-) Rs. 6,000	(+) Rs. 13,317
2015-16	Rs.34000	Rs.40450	Rs.63699	Rs.52695	Rs.29699	Rs.12245	1.87	1.30	(-) Rs. 6,450	(+) Rs. 17,454
Mean	Rs.32361	Rs.37233	Rs.51533	Rs.44626	Rs.19173	Rs.7393	1.58	1.20	(-) Rs. 4,873	(+) Rs. 11,779

recorded in demonstration practice rather than farmers practice which mainly attributed to higher yields with reduced cost of cultivation, which was realized by adoption of best management practices *like* improved seed, water conservation measures, INM and IPM *etc*. on cluster's approach and similar results also reported by Dubey *et al.* 2016. The average gross returns of three years is Rs. 51533 ha^{-1} in demo practice, which is 15.5 per cent higher than the farmer's practice (Rs.44626 per ha). The net returns of Rs.19173 ha^{-1} was recorded under demonstration practice and it was 259 per cent higher than the farmer's practice (Rs.7393 ha^{-1}). The mean benefit cost ratio of three years of demonstration package is higher (1.58) than farmers practice (1.20). Hence it is clearly indicated that the demonstrations with best management practices gave higher productivity and profitability compared with traditional farmer's practice.

CONCLUSION

Cluster front line demonstrations in bengalgram with improved seed, *insitu* moisture conservation, soil test based balanced nutrition, integrated pest and disease management practices were very much helpful in minimizing the cost of cultivation by cutting down the additional expenditure on pesticides and increased net returns to the farmers. From the three years of demonstrations, it is concluded that an amount of Rs. 4873 ha^{-1}. was saved from the cost of cultivation with adoption of best management practices and

realized the mean additional net returns of Rs.11779 ha^{-1}. to the bengalgram growing farmers under rainfed *vertisols* farming situation of YSR district. Further, these best management practices should be popularized in other areas having similar farming situation through exposure visits, capacity building programmes, print and electronic media and other innovative extension methodologies to harness sustainable production and to ensure our nation to become a surplus pulse production country.

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