International Journal of Food Science and Nutrition
ISSN: 2455-4898
Impact Factor: RJIF 5.14
www.foodsciencejournal.com
Volume 3; Issue 6; November 2018; Page No. 230-234

Frontline demonstrations: integrated crop management (ICM) in red gram with an Innovative approach of transplanting technology for higher yield at Bidar district of Karnataka

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Abstract
Pigeonpea is one of the most important and commercial pulse crop of Bidar district. The changing climate has its influence on flower drop, poor pod setting and low yields due to insect pest and disease incidence In this regard of view ICAR- Krishi Vigyan Kendra, Bidar conducted 149 frontline demonstrations (FLDs) in an area of 73 ha area in various farmers field of different villages \of Bidar district during the period from 2008-09 to 2016-17. The demonstration was conducted to enhance the yield of red gram through integrated crop management technology (ICM) along with transplanting of red gram (Bidar technology) with variety BSMR-736. The new technique red gram transplanting with ICM yielded highest average highest yield of 29.80 q/ha where as in farmer's practices the average yield was to 15.00 q/ha which was 98.60 per cent increase in the yield over farmer practices. The average technological gap, extension gap and technological index noticed were 29.02 q/ha, 12.73 q/ha and 114.19 per cent respectively and recorded the average net profit of Rs. 95919.22 per ha under demonstration while it was Rs 43270 per ha under farmer practices. Benefit cost ratio was 5.39 under demonstration where as it was 3.44 under farmer practices.

Keywords: transplanted red gram, net returns, integrated crop management, technological gap, extension gap, technology index

Introduction
Pigeon pea (*Cajanus cajan*) (Linn.) is an important pulse crop grown extensively for its rich protein content and forms important constituent of our daily vegetarian diet. India is the largest producer of pigeonpea contributing 90% of world production (Lateef and Pimbat, 1990) [5]. In India the avaidoble losses due to insect pest in pigeonpea was recorded to an extent of 78 per cent (Lateef and Reed, 1983) [4]. The per capita availability of pulses in India has been continuously decreasing which is 32.5 gm/day against the minimum requirement of 80gm/ day per capita prescribed by Indian Council of Medical Research (ICMR). In Karnataka pigeon pea occupies an area of about 6.04 lakh hectares with the production of 2.79 lakh tonnes, having an average productivity of 487 kg per ha. In Bidar district the red gram it covers an area of 67288 ha with average production and productivity of 237570.37 tonnes and 3530.67 kg per ha respectively (Annon, 2016) [2]. Increased pulse productivity will make India to self-sufficient by increasing from 560kg ha-1to 1,200 kg ha-1 by year 2020 as opined by Ali and Kumar (2005) [1].
The aim of frontline demonstrations on transplanted red gram with integrated crop management (ICM) technology is to identify the production constraints various group discussions were held by the team of ICAR- Krishi Vigyan Kendra (KVK), Bidar, Karnataka scientists and identify the various problems like faulty and improper sowing practices and higher seed rate usage, improper crop geometry and spacing, no usage of bio fertilizers, trichoderma, only application of Diammonium phosphate fertilizers, no weedicide usage and improper and exes usage and method of irrigation and finally the problems were prioritized and improved production technologies red gram transplanting with ICM practice were designed by involving farmers and scientists of KVK.
The demonstration is to convey the technical message to farmers that if they use recommended package they are sure to get higher yields, to know the technology gap between the potential yield and demonstrated yield, extension gap between demonstrated yield and yield under famers practice and technology index, through various extension methods including the Participatory Rural Appraisal (PRA) technologies to boost the production and productivity through transfer of technology. The yield data were collected from both the transplanted technology and farmers practice by random crop cutting method. Qualitative data were converted into quantitative form and expressed in terms of per cent increase in yield. (Narasimha Rao *et al.*, 2007) [6].

Methodology
The frontline demonstration was carried out by ICAR- Krishi Vigyan Kendra, Bidar (Karnataka state) during the period 2008-09 to 2016-17.

Selection of beneficiary

The beneficiaries were selected based on two criteria (i) Who are growing red gram crop, (ii) Who are willing to participate. There were 149 frontline demonstrations conducted over an area of 73 ha from last 9 years on transplanting of red gram with ICM technology in farmer's participatory mode under scientific management practices in different villages of Bidar district during Kharif season under transplanting with irrigated condition on heavy soils under red gram.

There were two treatments, one is recommended practices with pulse magic spray comprising varieties of red gram (BSMR-736) seedlings, 25:50:00:15 NPKZn kg/ha, One hectare area requires 2.5 kg red gram seeds, these seeds were treated with 2 per cent Calcium chloride for one hour and shade dried and treated with *Rhizobium* and *Phosphate solubilising bacteria* (PSB) @ 20 and *Trichoderrma viridae* @ 4g per kg of seed and fallowed integrated pest management. Moisture in the plastic bag was maintained with frequent irrigation as when required. One month old seedlings of red gram were transplanted in the main field at moisture level of field capacity with a spacing of 6 feet × 2.5 feet and entire dose of Nitrogen and Phosphorus through diammonium phosphate and Zn was applied as basal dose before transplanting. Fields were irrigated three times, one immediately after transplanting of seedlings, at pre flowering, at pod formation and anther at pod maturity stage. Nipping is done at 25-30 days after transplanting of red gram seedlings. 19:19:19: NPK @ 10g during or Pulse magic (Nutrient mixture) sprayed two times one at flowering and another at pod formation stage and also for the plant protection IPM measures were fallowed (T1).

In second treatment (farmers field) all the practices of treatment one (T1) except pulse magic spray, transplanting of seedlings (line sowing was fallowed), no nipping and herbicide usage and pesticides were used indiscriminately. The yield data were collected from both the demonstration (T1) and (T2) farmers practice by random crop cutting method. Ten plants were tagged at random in net plot area for recording various yield components like number of pods per plant, number of seeds per pod, seed yield per plant (g), 100seed weight (g), seed yield (kg ha-1) was computed by threshing pods from net plot, cleaned and the seeds weight was recorded. From this seed yield per hectare was computed. The net return (Rs. ha-1) was calculated by deducting cost of cultivation (Rs. ha-1) from gross returns and B: C was worked out as a ratio of gross returns (Rs. ha-1) to cost of cultivation (Rs. ha-1).

Table 1: Transplanting of red gram with ICM technology and Farmers practices of under FLD

S. No.	Technology	Improved practices	Farmers practice	GAP (%)
1	Variety	BSMR-736	Maruti (ICP 8863)	100
2	Land preparation	Ploughing and harrowing	Ploughing and harrowing	Nil
3	Pre-emergent herbicide	Pendimethalin (@ 2.5 l/ha)	No herbicide	Full gap
4	Seed rate	2.5 kg/ha	12 kg/ha	High seed rate
5	Sowing method	Transplanting of 30 day old seedlings	Line sowing with seed drill	Full gap
6	Seed treatment	Calcium chloride, *Rhizobium* and *Phosphate solubilising bacteria* (PSB) and *Trichoderrma viridae*	No seed treatment	Full gap
7	Time of sowing	2nd week of June	2nd week of June	Nill
8	Spacing	6 × 2.5 feet	3 X 1 feet	Partial gap
9	Fertilizer dose (NPK kg/ha)	25:50:0:25	10:25:0:0	Partial gap
10	Nipping	Nipping at 30 DAT	No nipping	Full gap
11	Plant protection	IPM	Indiscriminate use of pesticides	Full gap
12	Grading the produce	Grading followed	Not followed	Full gap
13	19:19:19: NPK or Pulse magic (Nutrient mixture)	2 times (flowering & pod formation	No spray	Full gap
14	Grading the produce	Grading the produce	Not followed	Full gap

Technology gap = Potential yield – Demonstration

Yield Extension gap = Demonstration yield – Farmers yield

Technology index = {(Potential yield - Demonstration yield) / Potential yield} X 100

Results and Discussion

Red gram is the most important commercial pulse crop of Bidar district which is also and the district is known as pulse bowl of Karnataka. The continuous use of local varieties, injudicious use of fertilizers and pesticides has deteriorated the soil health. The gap between the existing and recommended technologies of red gram in Bidar district is presented in table 1. Full gap was observed in case of use of variety, method of sowing, seed treatment, nipping, 19:19:19: NPK or Pulse magic (Nutrient mixture), with plant protection and weed management and partial gap was observed in fertilizer dose and spacing The transplanting which definitely had achieved potential yield where as in farmers practice the farmers were not aware about recommended technologies. Farmers in general used local or old-age varieties instead of the recommended high yielding resistant varieties and lack of awareness were the main reasons. Farmers followed line sowing with high seed rate as against transplanting technique.

Crop performance and yield

Frontline demonstrations on red gram transplanting with ICM technology are effective educational tools in introducing

various new technologies to the farmers and also to boost the farmer's confidence level by comparison of productivity levels between improved production technologies in demonstration trials. The performance of red gram crop owing to the adoption of improved technologies is assessed over a period of nine years and is presented in table 2, 3 and 4.

The study revealed that the average seed yield of red gram (BSMR-736) under transplanting technique was found to be higher (25.97 q/ha) as compared to farmers field (13.24q/ha) and recorded higher per cent seed yield (98.93%) over the farmers practice. Transplanting technique recorded highest seed yield (29.80q/ha) during 2010-11 and lowest seed yield 21.50q/h during 2015-16 where as farmers practice recorded highest seed yield of 16.00q/ha during 2012-13 and minimum seed yield 11.00q/ha during 2008-09. This increased yield in transplanted red gram is attributed use of pulse magic which supplemented the required nutrition at flowering and pod formation stage these finding are in confirmation with Pramod Kumar *et al.,* (1999) [8] who opined that foliar application of nutrient and growth regulator at pre flowering and flowering stage was seen on reduction in flower drop percentage in green gram. Number of flowers plant-1 was greater with the foliar application of 50 ppm salicylic acid at 24DAS. Sharma *et al.* (1993) [10] reported that salicylic acid enhanced the seed yield of soybean through early floral bud initiation, more flowers and pods plant.

The supplemental irrigation at immediately after transplanting helped in complete establishment of transplanted red gram plants helped to get cent per cent plant population and irrigation at pre flowering, pod formation stage and anther at pod maturity stage increased flower and pod setting resulted in more number of pods per plant, more number of seeds per pod so finally higher seed yield. These findings are on par with the findings of Prakash *et al.* (2003) [7] who reported the combined foliar application of NAA @ 30 ppm and mepiquat chloride @ 120 ppm recorded increased yield by 25 per cent. Foliar application of micronutrients at flowering and 20 days after first spray would have helped for reducing flower drop and contributed more for reproductive parts resulting in increased number of pods per plant. Data in table 2 noticed that the cost involved in the adoption of transplanting technology along with ICM using red gram variety BSMR-736 varied and was more profitable. The results are also in agreement with those of Chittapur *et al.* (1994) [3]. It is clearly indicated that the higher average seed yield in demonstration plots over the years compare to local check due to knowledge and adoption of full package of practices i.e. appropriate varieties such as BSMR-736, timely sowing, seed treatment with Bio fertilizers, use of balanced dose of fertilizer, method and time of transplanting, timely, pulse magic spray at flowering and pod development stage. The above findings are in similarity with the findings of Tomar (2010) [11]. The higher yield of chickpea under improved technology was due to use of latest high yielding varieties, integrated nutrient management and integrated pest management (Tomar *et al.*, 1999) [12].

Table 2: Impact of improved production technology on realization of productivity and potential of red gram.

Year	Area(Ha)	Technological gap (q/ha)	Extension gap (q/ha)	Technological index (%)
2008-09	15	25.30	18.70	85.19
2009-10	10	26.44	16.56	92.58
2010-11	12	25.20	14.80	84.56
2011-12	8	31.53	11.22	134.34
2012-13	4	28.50	10.50	107.55
2013-14	2	29.13	13.52	112.60
2014-15	4	30.40	10.05	123.58
2015-16	8	33.50	9.00	155.81
2016-17	10	31.25	10.25	131.58
Average		29.03	12.73	114.20

Table 3: Technological gap Extension gap and Technological index of red gram

Year	No. of Demonstrations	Area(Ha)	Yield Q/ha			% increase in yield over farmers practice
			Potential yields	Demonstration Yields	Farmers practice	
2008-09	15	15	50	29.70	11.00	170.00
2009-10	25	10	50	28.56	12.00	138.00
2010-11	30	12	50	29.80	15.00	98.67
2011-12	20	8	50	23.47	12.25	91.59
2012-13	10	4	50	26.50	16.00	65.63
2013-14	5	2	50	25.87	12.35	109.47
2014-15	10	4	50	24.60	14.55	69.07
2015-16	20	8	50	21.50	12.50	72.00
2016-17	14	10	50	23.75	13.5	75.93
Total	149	73	50	25.97	13.23	98.92

Table 4: Impact of improved production technology on economics of red gram

Year	Cost of cultivation (Rs/ha)		Gross return (Rs/ha)		Net return (Rs/ha)		B:C Ratio	
	Demo	Farmer practice	Demo	Farmer practice	Demo	Farmer practice	Demo	Farmer practice
2008-09	22625	19962	108000	40000	85375	20038	4.77	2.00
2009-10	22625	19800	107100	45000	84475	25200	4.73	2.27
2010-11	20100	16800	125160	63000	105060	46200	6.23	3.75
2011-12	19850	17450	84492	44100	64642	26650	4.26	2.53
2012-13	19250	16850	96900	58506	77650	41656	5.03	3.47
2013-14	20250	16780	108654	51870	88404	35090	5.37	3.09
2014-15	22750	17250	110700	65475	87950	48225	4.87	3.80
2015-16	23450	17730	194037	112812	170587	95082	8.27	6.36
2016-17	24370	18910	123500	70200	99130	51290	5.07	3.71
Average	21696.67	17948	117615.9	61218.1	95919.22	43270	5.40	3.44

Technology Gap

The technology gap means the differences between potential yield and yield of demonstration plot. The technology gap of demonstration plots were 25.30, 26.44, 25.20, 31.53, 28.50, 29.13, 30.40, 33.50 and 31.25 q/ha during 2008-09, 2019-10, 2010-11, 2011-12, 2012-13, 2013-14, 2014-15, 2015-16 and 2016-17 respectively (Table-3). On an average technology gap under nine year FLD programme was 29.02 q/ha. The technology gap observed may be attributed to dissimilarity in the soil fertility status, crop production, protection practices and local climatic situation.

Extension Gap

Extension gap means the differences between demonstration plot yield and farmers yield. Extension gap of 18.70, 16.56, 14.80, 11.22, 10.50, 13.52, 10.05, 9.00 and 12.73 q/ha was noticed during 2008-09, 2019-10, 2010-11, 2011-12, 2012-13, 2013-14, 2014-15, 2015-16 and 2016-17 respectively (Table-3). On an average extension gap under seven year FLD programme was 12.73 q/ha which emphasized the need to educate the farmers through various extension programs i.e. front line demonstration for adoption of improved production and protection technologies, to revert the trend of wide extension gap. More and more use of latest production technologies with high yielding varieties will subsequently change this alarming trend of galloping extension gap.

Technology Index

Technology Index indicates the feasibility of the evolved technology in the farmers' fields. Lower the value of technology index, higher is the feasibility of the improved technology. The technology index varied from 85.19 to 155.81 per cent (Table-3). On an average technology index was observed 114.19 per cent during the nine years of FLD programme, which shows the efficacy of good performance of technical interventions. This will accelerate the adoption of demonstrated technology transplanted red gram with ICM technology to to increase the yield performance of red gram.

Economic Return

From the table 4 it reveals that the cost involved in the adoption of improved technology in red gram transplanting with ICM technology varied and was more profitable. The average net return of Rs. 95919.22 per ha was recorded compared to farmers practice (Rs 43270 per ha) The average benefit: cost ratio of demonstration plots recorded was 5.39 as compared to farmers field 3.44.

The red gram transplanting with ICM technology gave higher net return of Rs. 85375, 84475,105060, 64642, 77650, 88404, 87950, 170587 and 99130 per ha respectively, as compared to farmers practices (Rs 20038, 25200, 46200, 26650, 41656, 35090, 48225, 95082 and 51290 per ha during 2008-09, 2019-10, 2010-11, 2011-12, 2012-13, 2013-14, 2014-15, 2015-16 and 2016-17 respectively). Similar findings were reported by Singh *et al.* (2014). The benefit cost ratio of transplanted pigeon pea (BSMR-763) cultivation under improved and cultivation practices higher than farmer's practices this may be due to higher yield obtained under improved technologies compared to farmers practice (Raju Teggelli *et al., 2016*) [9]. Foliar application of 1.0% WSF at both peak flowering and pod development stages recorded higher gross returns (Rs. 68,049 ha^{-1}) and net returns of Rs. 46,299 ha^{-1} (Yadav *et al.*, 1997) [13]. Foliar application of Pulse magic a micro nutrient mixture has shown significant effect on nutrient uptake by the crop as compared to lower uptake of nutrients recorded in control.

Conclusion

It is concluded from the study that there exists a wide gap between the potential and demonstration yields in transplanted pigeon pea (BSMR-736) mainly due to technology and extension gaps and also due to the lack of awareness about new transplanting technology in red gram Bidar district of Karnataka. The productivity gain under frontline demonstration over farmers practices of red gram cultivation created greater awareness and motivated the other farmers to adopt suitable production technology of red gram in Bidar district.

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