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Research Article

Integrated MYMV management techniques with a novel crop-stand establishment for black gram (*Vigna mungo*) under pulse-wheat cropping system in Bundelkhand region

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Abstract Tikamgarh district related to Agro-Climatic Zone of Madhya Pradesh (MP) was studied during 2017-18 considering district as its agricultural zones as unit of investigation because of a marked variation prevails in soil, climate, cropping pattern, area and productivity which divide in several blocks. In technology-3 with IPU 94-1 resistant variety with an average mean yield (14.3 q/ha) as against a yield with a mean of 8.0 q/ha recorded under farmer's practices. The incidence of MYMV was recorded 1% in technology-3 but the disease incidence was highest 23% in farmers practice. The results were found highly significant increase in yield and growth attributes of black gram on resistant variety of MYMV disease with integrated disease management technologies and reduced disease incidence as comparison to farmer practices. The technology index was 26.6%, while 30 % maximum technology index was in technology-3. The high yield and disease resistant varieties with disease management technologies were found the main factors to give the high achievement on black gram production while farmers were unaware about these resistant varieties and disease management practices. Farmers were convinced due to performance of technologies and accepted the ones but farmers want availability of new technologies inputs timely at local market. These technologies further could be taken under front line demonstration programme for large scale adoption horizontal and vertical spread among tomato grower of the district.

Keywords: MYMV, Black Gram, BBF, IDM

Introduction

Black gram (*Vigna mungo*) is one of the most important legume crops of India. Being a pulse it has vital role in nutritional security and major sources of vegetable proteins in Indian diet. India is the world's largest producer of pulses imports a large quantity of pulses to meet out the growing domestic needs. It contains about 20% protein, which is almost three times higher than cereals, other minerals and vitamins. The demand of pulses particularly black gram is supplied across the world due to its higher consumption where animal proteins are insufficient and comparatively expensive (Ofuya and Akhidue, 2005). It is resistant to adverse climatic conditions and improves the soil fertility by fixing atmospheric nitrogen in soil and contribute in crop produce equivalent to 22.10 kg of N/ha. The total black gram production in India was 2.89 million tonns from an area of 3.56 million hectares (Ministry of Agriculture and Farmer's welfare annual report 2016-17). In Madhya Pradesh, total area was 9.32 lakh hectare with total production of 515 million tonns and productivity of 553 kg/ ha.

Since last few years the average production and productivity has declined due to attack of insect pests, diseases and drastically changes of climatic conditions. Soil and climatic conditions play an important role in crop rotation, mixed and inter-cropping, leading soil fertility via nitrogen fixation, release of soil-bound phosphorus ultimately contribute significantly to sustainability of the farming systems. It is therefore, necessary to assess the technological intervention gaps in production and also to know the problems and constraints in adopting improved variety of black gram production technologies (Islam *et al.,* 2011 and Kumar et al., 2014).

Availability of quality seed of improved varieties and other inputs is one of the major constraints in increasing the production of legume crops. In this context, Krishi Vigyan Kendra, Tikamgarh (MP.) is a grass root level organization meant for catering application of technology through demonstrations (cluster front line demonstration and on farm testing), training schools, yield assessment, refinements and dissemination of proven technologies under different micro farming situation in the district levels (Dubey *et al.,* 2010). The major reasons of fluctuating pulses production are climatic abnormalities. The extreme weather events are more vulnerable on pulse crops followed by oilseeds and cereals (Gautamand Bambawale, 2013 and Singh *et al*.,2013). The frequency of occurrences of extreme weather events such as drought, floods, heat waves, cold waves, unusual and unseasonal rainfall, cyclones, frost and hail storm is on the rise in recent years than in the past (Prasad *et al.,*2010)

Several researchers reported all over losses of black gram due to insect pests in India conditions, 7 to 35% caused by insect pest complex of different agro-climatic conditions (Hamad*et al.,*1983) whereas combined infestation of pests and diseases annual estimated yield lose over 30% in dry land conditions (Justin*et al.,*2015).YMV disease of black gram caused heavy yield loss from 10 to 100%, depending upon the crop stage at which the plants get infected, whereas up to 21% yield loss reported by powdery mildew (Singh*et al.,*2013). Study on all insect pests showed negative correlation with maximum temperature while positive correlation with maximum relative humidity and total rainfall. However, climatic stresses effect on area, productivity and comparative performance of mitigation technologies to abiotic and biotic stresses on black gram is completely lacking. Therefore, the present study was undertaken to analyses factors affecting changes in area, productivity of states of Central India (Madhya Pradesh and Chhattisgarh) and technological impact on increasing yield and benefits of black gram in changing climatic scenario.

Though, huge numbers of resistant / tolerant varieties of black gram have been developed by researchers but dissemination of such varieties at farmers' field level is experienced very scanty. This is due to the lack of knowledge and awareness in the farmers and gap of new transfer technology, motivational trainings through field demonstrations to build up reliance towards the changing them. The sowing method of black gram and most of the Kharif major crops of Bundelkhand zone is broad casting method or flatbed method which become poor drainage during heavy rain uneven rain and less moisture conservation effectively during draught or low rainfall condition therefore the technologically interventionwith black gram variety IPU 94-1+ raised bed (10-inchheight x15-inch width &5-inchdepth) plating through raised bedplanter carried out during rainy seasons of two consecutive years 2017 to 2018 in the farmers' fields of 05-villages of the district Tikamgarh (M.P.) in Agro-Climatic Zone, Bundelkhand of Madhya Pradesh in rainfed condition on medium and light soils with low to medium fertility.

Materials and Methods

Tikamgarh district related to Agro-Climatic Zone of Madhya Pradesh (MP) was studied considering district as its agricultural zones as unit of investigation because of a marked variation prevails in soil, climate, cropping pattern, area and productivity which divide in several blocks. The district information on area, productivity and climatic vulnerability of black gram was collected from directorate of agricultural land records and contingent plan of MP. The present study was carried out by the Krishi Vigyan Kendra, Tikamgarh (M.P.) during rainy seasons of two consecutive years 2017 and 2018 in the farmers' fields of 05-villages of Tikamgarh and Jatara block of the district in agro-climatic zone in rainfed condition on medium soils with low to medium fertility. Each demonstration was conducted in an area of 0.1 ha and 0.1 ha area adjacent to the demonstration plot as farmer's practices i.e. prevailing cultivation practices served as local check. All 25-on-farm testing trails demonstrations in 2.5 ha area with randomized block design (RBD) and each treatment replicated in -5 replications, farmer practice as local check replication. The technologies modules were T_1 (Technology-1/check-1) = Farmers practice (Variety-Local and old-T-9 + indiscriminate use of insecticides), T_2 (technology-2)= Variety IPU 94-1 + Seed treatment with Imidacloprid 60 FS @ 5 ml/Kg of seed to minimize seed borne virus infection and white files population + raised bed (10-inch height x 15-inch width & 5-inch depth) plating through raised bed planter(source of technology CSA, Kanpur 2008 & JNKVV, Jabalpur, 2016) and T_3 (technology-3)= Technology-2 + after germination of seeds, spray the crop with (Imidacloprid 200 SL @ 0.3 ml/l or Thiomethoxam 25 WP @ 0.3 g/l) at15-days after interval need based sprayed when appear MYMV in a few plants to minimize their spread.

The experimental plots sowing was made on commencement of monsoon 25th June to 1st July week of July during both the years. The individual plot size was 0.1 ha per treatment. Raised bed (10-inch height x 15-inch width & 5-inch depth) plating through raised bed planter were made. The experimental plots were interspaced at 1.0 m. Each cultivar was given the same management treatments *i.e.* fertilization, irrigation, weeding and different technologies modules against MYVM and vulnerable climatic conditions. Compost @10 tons/ha and 20:40:40 kg NPK/hawas applied as basal full dose during field preparation except nitrogen half dose andhalf dose of nitrogen was applied as top dressing in two equal splits at 30 and 50 days after transplanting. Lifesaving irrigation wasnot applied as and when necessary to assayed the BBF impact.

Normal cultural practices were adopted to raise the crops successfully. The observations in each plot every year to record the on number of pods/plant, seeds/pod, averagetest weight of seeds survivability at harvest and the yield was recorded on plot basis. The MYMV incidence and severity were recorded 30- days after sowing. The severity was rated in 3 grades, 1- mild symptom (light foliar yellowing), 2- moderate symptoms (light foliar yellowing, curling and slight plant stunting) and 3-severe symptoms (very severe plant stunting, leaf size reduction, leaf curling and yellowing). The mean data for all observations over two years were pooled and statistically analyzed following standard procedure.Evaluate response of technologies for escaping abiotic and biotic stresses of climatic abnormalities.

Materials for the present study with respect to OFT was on following

T_1-(Technology-1/check-1) =Farmers practice (Variety-Local and Old-T-9 + indiscriminate use of insecticides),

T_2 (technology-2) = Variety IPU 94-1 + Seed treatment with Imidacloprid 60 FS @ 5 ml/Kg of seed to minimize seed borne virus infection and white files population + raised bed (10-inch height x 15-inch width & 5-inch depth) plating through raised bed planter (source of technology CSA, Kanpur 2008 & JNKVV, Jabalpur, 2016)

T_3 (technology-3) = Technology-2 (Variety IPU 94-1 + Seed treatment with Imidacloprid 60 FS @ 5 ml/Kg of seed to minimize seed borne virus infection and white files population + raised bed (10-inch height x 15-inch width & 5-inch depth) plating through raised bed planter (source of technology CSA, Kanpur 2008 & JNKVV, Jabalpur, 2016) + after germination of seeds, spray the crop with (Imidacloprid 200 SL @ 0.3 ml/l or Thiomethoxam 25 WP @ 0.3 g/l) at 15-days after interval need based sprayed when appear MYMV in a few plants to minimize their spread.

In OFT demonstration plots, critical inputs in the form of quality seed and treatment, farm manure, balanced fertilizers and agro-chemicals were provided by KVK. For the study, assessment and refinement of different IDM+ CPM technologies for suitability at local or micro-climatic situation so that these technologies would be further accepted or rejected or refined as per feedback of technological and farmers. The suitable modules were assessed for large scale demonstrated among more farmers for diffusion and adoption of technology for management of MYMV of black gram. The technological gap, extension gap and technology index were calculated as suggested by Samui, *et al*. (2000).

Technology gap = Potential Yield- Demonstration yield

Extension gap = Demonstration Yield-Farmers yield

$$\text{Technology index (\%)} = \frac{\text{Technology gap}}{\text{Potential yield}} \times 100$$

Results and Discussion

1. Effect on black gram yield, growth parameters and MYMVdisease

Black gram yield

The yield of black gram under different integrated MYMV disease management technologies ranged from 7.5 to14.8 q/ha with highest average yield 14.3 q/ha. The cultivation of black gram with MYMV management + CPM technologies, the yield ranged from with mean average 8.0 to 14.3 q/ha,(average mean (11.9 q/ha) with MYMV resistant variety IPU 94-1+ CPM- in technology-2, while in technology-3 with same resistant variety 13.8 to 14.8 q/ha with an average mean yield (14.3 q/ha) during 2017-18 to 2018-19 (Table-1) as against a yield ranged 7.5 q/ha to 8.5 q/ha with a mean of 8.0 q/ha recorded under farmer's practices (technology-1, local check) in an average mean of both the years. The number of pods were also recorded highest in technology-3.

This finding is in corroboration with the findings of Archana *et al*., (2018), Jayappa *et al*., 2017,Rhadika*et al*., 2018 and Swathi*et al.,* 2018.

Table 1Effect of different technologies for MYMV disease management in black gram on yield (q/ha), disease incidence, No. of pods/plant and test weight of 1000 seeds at farmers, fields during two consecutive years (2017- 2018).

Years	Data on parameters of observations											
	Yield (q/ha)			MYMV incidence (%)			No. of pods/plant			Test weight seeds (g)		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
2017	7.5	11.4	13.8	24	3	1	14	20	26	27	32	38
2018	8.5	12.4	14.8	22	2	1	16	25	30	25	29	34
Total	16	23.8	28.6	46	5	2	30	45	56	52	61	23.8
Average	8.0	11.9	14.3	23	2.5	1	15	22.5	28	26	30.5	11.9

Note = T_1= (Farmers, practice), T_2= Technology-1, T_3 =Technology-2, AV= Average

The additional black gram yield under technology-2 over local check ranged from 11.4 to 12.4 q/ha with a mean of 11.9 q/ha. In comparison to local check there was an increase of 48.9 % in yield of black gram with technology-1(Table-2) in both the years' means. The increased black gram yield with variety IPU 94-1+ CPM technology-2 was mainly because of use improved MYMV resistant variety and CPM (Crop Practices Management) technology. While the additional yield of black gram over local checked ranged from 13.8 to 14.8 q/ha with a mean of 14.3 q/ha in the same variety and CPM technology-3 for MYMV dieses management in mean of both the years.The increased in comparison to over farmer practice was 36.9 % in both the years mean. The overall performance among technologies, the highest yield and increased over farmers check was in Technology-3. This finding is in corroboration with the findings of Archana *et al*., (2018) and Jayappa *et al.,* (2017) where they reported seed treatment with Imidacloprid contributed to relatively low disease incidence of YMV on blackgram. Swathi*et al.* (2018) reported foliar spray with Flonicamid 50 WG @ 0.0325% was found to be very effective in reducing YMV disease incidence (17.66%). Similarly, Ghosh *et al.* (2009), reported that Imidacloprid and Thiamethoxam were more effective in reducing the incidence of YMV when compared to conventional insecticides. The systemic nature of Thiamethoxam and Imidacloprid on the insect vector at initial stages might be the reason for low disease incidence. The present results are agreed with Archana *et al*., (2018) and Jayappa *et al*., (2017) where they have revealed that seed treatment with Imidacloprid contributed to relatively lowest populations of whitefly. Corresponding results were reported by Rhadika*et al*., (2018), lowest population of whiteflies were recorded in seed treatment with Thiamethoxam @ 3 g/kg with 2.40 whiteflies and was on par with seed treatment of Imidacloprid @ 5 g/kg with 2.60 whiteflies per six leaves. Swathi*et al.,* (2018) reported foliar spray of Flonicamid @ 0.0325% was found to be highly effective in reducing whitefly population

Table 2Effect of different technologies for MYMV disease management in black gram on increased yield (q/ha), decreased in disease incidence, increased in No. of pods/plant and test weight of 1000 seeds over control at farmers, fields during two consecutive years (2017- 2018).

Years	Data on parameters increased or decreased(%) over control											
	Increased in yield			Decreased in MYMV			Increased in pods			Increased in test weight		
	T_2	T_3	Av.	T_2	T_3	Av	T_2	T_3	Av	T_2	T_3	Av.
2017	52.0	84	68	87.5	95.8	91.6	42.8	85.7	64.2	18.5	40.7	29.6
2018	45.8	74.1	5.9	90.9	95.4	93.1	56.2	87.5	71.8	16	36	26
Total	97.8	158.1	73.9	178.4	191.2	184.7	99	173	136	28.6	97.8	158.1
Average	48.9	79	36.9	89.2	95.6	92.3	49.5	86.6	68	14.3	48.9	79.05

Effect on growth parameters of black gram

Data on other parameters i.e. number of pods/plant and test weight of 1000 seeds (gm) of black gramwas also found increased in both the technological intervention over farmers, practices (Table-2). The average number of pods/plant with an increased 49.5% and 86.6 % in an average mean of both the years respectively, in technology-2 and technology-3 over farmer practices. The average mean test weight of seeds was also recorded an increased trend 14.3% and 4.9% with over farmers' practices. The highest performance in all parameters of black gram was recorded on technological intervention-2 (T-3). This finding is in corroboration with the findings of Venkatesan, 2017 and Basavaraj, 2012. The results were positively correlated with Archana *et al.,* (2018) and Jayappa *et al.,* (2017). The seed yield and other yield attributes were low from the treatments with high MYMV incidence of which was in accordance with earlier reports. A strong negative correlation was recorded between the incidence of MYMV and yield attributes (Gupta, 2003).

Decreased in MYMV disease (%) of black gram

The significant data on highest decreased in MYMV disease of black gram were recorded 89.2% and 95.6% in both the years mean over farmers' practices, respectively in technology-2 and technology-3. The incidence of MYMV was recorded least 2 % in technology-2 and while 1% in technology-3 but the disease incidence was highest 23% in farmers practice on the mean basis of both the consecutive year (Table 1). Similar, results were also reported that the infected black gram plant produce small sized pods, yellowing of the leaves reduces the photosynthetic ability which ultimately manifested as severe yield penalty (Malathi and John, 2008). At suitable climatic conditions, MYMV disease is widespread and destructive, can cause yield loss 5- 100% annually (Nene, 1972; Varma *et al.,* 1992, Ghafoor *et al*., 2000; Singh *et al*., 1982, Rathi, 2002).

2. Economics analysis

Net Return

The economic viability of improved technologies over traditional farmer's practices was calculated depending on prevailing prices of inputs and outputs costs (Table-3). It was found that cost of production of black gram varied from Rs.14000 to 15000 in farmer practices (T_1) to 16000 to 17000 (T_2) and 18000 to 19000 /ha in (T_3) with an average of Rs.14500, 16500and 18500/ha of improved technologies both the year as against the variation in cost of production from Rs.14000 to 15000/ha with an average of Rs.14500/ha in local check in both the years. The improved production technologies registered agrass return from Rs. 26250/ha to 62160 with a mean of Rs.30975/ha and 55352/ha in the all treatment, while in technology-2 it was Rs. 45990/ha and Rs. 55352 in technology-3. The additional cost incurred in the improved technologies as compared to farmer's practices was mainly due to more costs involved in inputs of technologies.

Table 3 Economical analysis of cost of cultivation, gross cost, net return (Rs/ha) and cost benefit ratio of different technological modules for management of MYMV disease in black gram at farmers, fields during two consecutive years (2017-2018).

Years	Cost of cultivation (Rs/ha)			Gross return (Rs/ha)			Net return (Rs/ha)			B C ratio		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
2017	14000	16000	18000	26250	39900	48545	12250	23900	30545	1.8	2.4	2.6
2018	15000	17000	19000	35700	52080	62160	20700	35080	43160	2.3	3.0	3.2
Total	29000	33000	37000	61950	91980	110705	32950	58980	73705	4.1	5.4	5.8
Average	14500	16500	18500	30975	45990	55352	16475	29490	36852	2.0	2.7	2.9

***Sale rate of black gram @ Rs. 3500/quintal (2017), Rs. 4200/quintal (2018)**

The yield of black gram under improved technologies gave higher net return ranged from Rs.30545 to 73705 /ha, with a mean value of Rs.29490/ha and Rs. 36852/ha, with a mean value of Rs. 16475/ha as compared to local check mean value. There was an additional net return of Rs.23900/ha to 35080/ha and Rs.30545/ha to 43160/ha in the years respectively, technology -2 and technology-3 under demonstration plots. The improved technologies also gave higher benefit cost ratio 2.6 to 3.2 compared to 1.8 to 2.3 under local check in the corresponding seasons in technology-2 and 3, respectively. 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 ofMalathi and John, 2008, Nene, 1972; Varma *et al.,* 1992, Ghafoor *et al*., 2000; Singh *et al*., 1982 and Rathi, 2002.The results from the current study clearly brought out the higher potential yield and MYMV disease resistant variety as well as improved integrated disease management technologies in enhancing black gram production, reducing highest incidence of MYMV and economic grains in Tikamgarh district condition of Madhya Pradesh.

Table 4Economical analysis of cost of cultivation, gross cost, net return (Rs/ha) and cost benefit ratio of different technological modules for management of MYMV disease in black gram at farmers, fields during two consecutive years (2017-2018).

Years	Data on economic analysis of different technologies over T1								
	Increased in Cost of cultivation			Increased in Gross return			Increased in Net return		
	T_2	T_3	AV.	T_2	T_3	Av	T_2	T_3	Av.
2017	14.2	17.9	25.0	52.0	48.5	50.2	95.1	149.3	122.2
2018	11.7	18.9	15.3	45.8	74.1	59.9	69.4	108.5	88.9
Total	25.9	36.8	40.3	97.8	122.6	110	164.5	257.8	211.1
Average	12.9	18.4	20.1	48.9	61.3	55.0	82.2	128.9	105.5

The data on economics cost analysis increased were also studies. The data was indicating that increased in cost of cultivation was due to enhancement the components of technologically interventions like insecticides, improved variety, and ridge furrow and raised bed planting inclusion while not increased in farmers' practices were found due to farmers were used local variety which was prone to MYMV and flat bed or broad casting sowing method of technology.

Technology gap

The technology gap in the demonstration black gram yield over potential yield were 5.4 q/ha in 2017 and 4.8q/ha in IPU4-1 with an average on both the years 5.1 q/ha in both the years on the same variety and its respective technologies for MYMV disease management in black gram (Table 5). The technological gap may be attributed to the dissimilarity in the soil fertility status and weather conditions

Table: 5. Extension gap (q/ha), Technology gap (q/ha) and technology index (%) on demonstration of IDM+ CPM intervention

Year	Technology	Yield (q/ha)					Ext. gap (q/ha)	Tech. gap (q/ha)	Tech. Index (%)
		Potential	Improved technology			Local Check			
			T_2	T_3	Av.				
2017	IPU 94-1	18	11.4	13.8	12.6	7.5	5.1	5.4	30.0
2018	IPU 94-1	18	12.4	14.8	13.2	8.5	4.7	4.8	26.6
Average		18	11.9	14.1	12.9	8.0	4.9	5.1	26.8

Extension gap

The highest extension gap of 5.1 q/ha was recorded in black gram variety IPU 4-1 and the lowest was observed in 4.7q/ha in the same variety with CPM technology. This emphasized the need to educate the farmers through various means for the adoption of improved tomato production technologies to reverse this trend of wide extension gap. More and more use of latest production and IDM technologies with high yielding and resistant 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 5).

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. The technology index was 26.6%, while 30 % maximum technology index was in technology-3 with IPU 94-1 and CPM during 2017-2018 (Table 5).

Conclusion

The results were found highly significant increase in yield and growth attributes of black gram on resistant variety of MYMV disease with integrated disease management technologies and reduced disease incidence as comparison to farmer practices. The high yield and disease resistant varieties with disease management technologies were found the main factors to give the high achievement on black gram production while farmers were unaware about these resistant varieties and disease management practices. Farmers were convinced due to performance of technologies and accepted the ones but farmers want availability of new technologies inputs timely at local market. These technologies further could be taken under front line demonstration programme for large scale adoption horizontal and vertical spread among tomato grower of the district.

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