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An Evaluation Study on Yield Sustainability of Rice Fallow Blackgram (*Vigna mungo*) Through Frontline Demonstrations Approach

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ABSTRACT

Background: Pulses are poor man's protein in India contributing to 25% world's share and its share to total food grain production declined to 8% (2023) resulting import of pulses. To stabilise the area and production expansion, the study aimed to achieve potential yield blackgram under rice fallow in Cauvery delta zone, Tamil Nadu, reducing technology gap in adoption of enhanced varieties and scientific technologies through frontline demonstrations.

Methods: In 2021, scientific investigation was conducted using cluster village methodology to examine the effects of technology index and yield attributes on yield sustainability in blackgram through Krishi Vigyan Kendra by evaluating 205 demonstrations in Tiruchirappalli district experimenting trials on Yellow Mosaic Virus (YMV) resistant varieties VBN6, KKM 1, ADT 6 and VBN 8 and yield maximizing technologies.

Result: Study revealed yield increase (38.90%) in demonstration plots than in farmers'. The major yield attributes - germination %, number of pods/plant, plant height, pod length and seed yield/plant had positive and highly significant impact on yield. Average technology index of demonstrations is 5.32%. Average net returns in demonstrations were higher (Rs.67050/ha) than farmers' plot (Rs.40100/ha). This greater Yield Sustainability resulted with adoption of seed drill sowing, YMV resistant cultivars, TNAU pulse wonder, seed treatment.

Key words: Blackgram yield maximizing technologies, Frontline demonstrations, Independent sample t-test, Pearson correlation coefficient, Technology index, Yield attributes.

INTRODUCTION

Pulses play a crucial role in ensuring food security while simultaneously enhancing soil properties through biological nitrogen fixation.The production of pulses had increased by 5% (Moong-12%, Gram -11%,Tur-9%, Urd-6% and Lentil-4%) during the period from 2015-16 to 2021-22 which impacted the livelihoods of more than five crore farming families in India. Even then the current output cannot meet the demand and India imports to meet the insufficiency. India contributing to 25% share to world's but its share to total food grain production declined from 16% (1950) to 8% (2023). Therefore India imports pulses to meet the demand and this can be stabilised by area and production expansion. Among the pulses, blackgram (urdbean) crop attained phenomenal increase in acreage since 2017-18 (48 lakh ha). Ten states contribute to 93 per cent of blackgram production with major contribution by Madhya Pradesh (32% production) followed by Andhra Pradesh, Uttar Pradesh, Tamil Nadu, Rajasthan, Maharashtra, Jharkhand, Gujarat, West Bengal and Karnataka (Annual Report 2022-2023, DPD, Bhopal www.dpd.gov.in as on 20.02.2024).

Among pulses, blackgram (*Vigna mungo*) stands out as a significant crop, contributing 2.84 million tons of production in India and 2.77 lakh tons in Tamil Nadu during 2021-22. In Tamil Nadu, Cauvery Delta Zone (CDZ) takes lead in both area (3.1 lakh hectares) and production of pulses which are grown using residual moisture after *Samba* rice crop during *Rabi* season (December to January) contribute over 40% to state's pulse production. However, yield of these rice fallow pulses remains suboptimal, varying from 300 - 500 kg/hectare, in contrast to the potential

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yield achievable under irrigated conditions. In CDZ of Tiruchirappalli district, cultivation of blackgram, within the wetland rice ecosystem follows traditional practices, either manually broadcasting seeds in standing rice fields 7 to 10 days before harvest or dibbling immediately after rice harvest. This low-cost approach focuses on sowing and seed expenses. Black gram grew as succeeding crop in non-puddled transplanted rice recorded more nodules (23.67) with yield increase (11.8%) above puddle method of tillage (Subrahmaniyan *et al*., 2023). The present research was conducted during 2021 aimed to evaluate blackgram for its yield attributes and technology gap analysis under residual soil moisture cultivation to reap greater financial returns utilizing high-yielding cultivars and scientific methods in contrast to local farmers' practices.

MATERIALS AND METHODS

The study evaluated 205 field demonstrations in 82 hectares conducted in seven blocks of Tiruchirappalli district-Andanallur, Lalgudi, Manikandam, Musiri, Thiruverumbur, Thuraiyur and Uppiliyapuram during 2018-19 to 2020-21 at Krishi Vigyan Kendra (KVK), Tiruchirappalli, Tamil Nadu. Various KVK interventions, including On-farm Trials (OFT), FLDs, Cluster FLDs and demonstrations from the National Food Security Mission (NFSM) seed hub, were implemented to enhance black gram production.

Data on yield qualities/parameters, including technology index, Pearson correlation coefficient and independent sample t-test, were analyzed in the research. Latest short-duration, drought-tolerant Yellow Mosaic Virus (YMV) resistant black gram varieties (VBN 6, ADT 6, KKM1 and VBN 8) were assessed through field trials and yield-maximizing technologies *viz*., seed rate optimization, seed drill sowing, seed treatment with biocontrol agents, crop booster TNAU pulse wonder applications and Integrated Pest and Disease Management practices were evaluated. The performance of yield attributes of blackgram on yield was assessed using Pearson correlation analysis and Independent sample T-test by collecting data from 25 plant samples from demo and farmer plots in 2021. The yield attributes taken into account for this research are X1 - Germination %; X2 - Plant height in cm; X3 - No. of pods/plant; X4 - Pod length in cm; X5 - No. of seeds/pod; X6 - Pod filling %; X7 - Seed yield g/plant.

The Pearson correlation coefficient (r) is a descriptive statistic that lists the characteristics of a dataset and calculates a linear correlation. A value between -1 and 1 indicates the strength and direction of relationship between two quantitative continuous variables. In order to compare the means of two sample groups and to ascertain statistically significant difference between means of two sets of data, the Independent sample T-test is used.

Marlabeedu *et al*.'s (2022) formulas on technology index were studied in order to evaluate and quantify the influence of demo plot yield against yield obtained through traditional farmers' practices (control plot).

Impact yield =

$$\frac{\text{Yield of demo plot - Yield of control plot}}{\text{Yield of control plot}} \times 100$$

Technology index (TI) =

$$\frac{\text{Potential yield - Demo plot yield}}{\text{Potential yield}} \times 100$$

The scientists regularly visited the fields and monitored periodically and data on yield parameters were collected from farmers during harvest both in demo and control plots. The details on cost of production and net returns have been collected from farmers in the research area. Evaluation of yield attributes and technology gap on yield through demonstrations in blackgram was analyzed and results are presented below:

RESULTS AND DISCUSSION

Performance of yield attributes of blackgram on yield

The study revealed that demo samples recorded higher germination (72%) than control plot (67.68%) with 6.4% increase in germination over the control variety (Table 1). Plant height, number of pods/plant, length of pods, number of seeds/pod, pod filling percentage and number of seed produced per plant were all consistently larger in the demo plot variety of blackgram than in control plot variety. These factors enhanced the average yield in demo plot as 8.57 q/ha compared to control 7.07 q/ha. Similar results were reported by Kamaleshwaran and Karthiga (2021).

The results of Pearson correlation analysis showed that following yield attributes had a direct positive influence on yield: germination percentage, pod number /plant, plant height, pod length, seed yield/plant were noteworthy at 1% level of significance on blackgram yield, while number of seeds/plant and pod filling percentage were discovered to be quite important at 5% of level of significance (Table 2). When comparing yield of blackgram between demo and control plot sample populations, the independent sample t-test analysis showed that following factors were highly significant: germination percentage, plant's height, number of pods/plant, pod length, number of seeds/plant, pod filling percentage and seed yield/plant (Table 3 and Fig 1). This discloses that new blackgram cultivars suitable for rice fallow conditions should possess higher germination percentage, a greater number of pods and seeds/plant to give high yield under limited resources.

Evaluation of blackgram technologies implemented under frontline demonstrations

Percentage increase in productivity

Blackgram demonstration plot and farmers plot yield are compared in order to calculate the impact yield and resulted in a yield increase of 38.90% over farmers' plots as demo farmers fully adopted practices like YMV resistant varieties,

Table 1: Observation on yield attributes on yield of blackgram under rice fallow conditions during 2021.

Sample	X1		X2		X3		X4		X5		X6		X7		(Y) Yield q/ha	
	Demo	Control	Demo	Control	Demo	Control	Demo	control	Demo	Control	Demo	Control	Demo	Control	Demo	Control
Sample 1	77	71	40	38	38	31	4.4	3.9	7	5	87.50	83.33	14.25	11.47	9.26	7.68
Sample 2	73	69	38	35	36	30	4.1	3.7	6	5	75.00	83.33	13.5	11.1	8.78	7.44
Sample 3	72	68	37	34	35	29	4.1	3.6	6	5	75.00	83.33	13.125	10.73	8.53	7.19
Sample 4	70	66	36	33	34	28	4.0	3.5	6	4	75.00	66.67	12.75	10.36	8.29	6.94
Sample 5	71	68	35	32	32	27	4.2	3.4	6	4	75.00	66.67	12	9.99	7.80	6.69
Sample 6	72	67	36	32	33	26	4.1	3.3	6	5	75.00	83.33	12.375	9.62	8.04	6.45
Sample 7	74	68	39	33	35	27	4.2	3.5	7	5	87.50	83.33	13.125	9.99	8.53	6.69
Sample 8	75	69	39	37	37	30	4.3	3.4	7	5	87.50	83.33	13.875	11.1	9.02	7.44
Sample 9	76	70	40	37	38	31	4.4	3.2	7	5	87.50	83.33	14.25	11.47	9.26	7.68
Sample 10	69	65	38	35	35	30	4.0	3.7	6	4	75.00	66.67	13.125	11.1	8.53	7.44
Sample 11	68	64	37	34	34	27	3.8	3.4	6	4	75.00	66.67	12.75	9.99	8.29	6.69
Sample 12	70	66	39	36	36	28	3.9	3.6	7	4	87.50	66.67	13.5	10.36	8.78	6.94
Sample 13	71	69	38	35	35	27	3.7	3.3	7	5	87.50	83.33	13.125	9.99	8.53	6.69
Sample 14	74	70	40	38	37	30	4.3	3.9	7	5	87.50	83.33	13.875	11.1	9.02	7.44
Sample 15	73	68	39	37	36	30	4.0	3.7	7	5	87.50	83.33	13.5	11.1	8.78	7.44
Sample 16	76	69	41	38	38	32	4.1	3.8	7	5	87.50	83.33	14.25	11.84	9.26	7.93
Sample 17	70	68	40	38	34	28	4.0	3.5	7	5	87.50	83.33	12.75	10.36	8.29	6.94
Sample 18	72	69	39	37	35	29	3.9	3.5	7	5	87.50	83.33	13.125	10.73	8.53	7.19
Sample 19	71	68	38	35	36	29	3.7	3.4	7	5	87.50	83.33	13.5	10.73	8.78	7.19
Sample 20	69	65	37	34	33	27	3.6	3.2	6	4	75.00	66.67	12.375	9.99	8.04	6.69
Sample 21	68	64	37	33	32	25	3.5	3.1	7	4	87.50	66.67	12	9.25	7.80	6.20
Sample 22	70	65	38	35	34	26	3.9	3.6	7	4	87.50	66.67	12.75	9.62	8.29	6.45
Sample 23	72	66	39	36	35	27	4.0	3.6	7	5	87.50	83.33	13.125	9.99	8.53	6.69
Sample 24	74	71	40	37	37	29	4.2	3.7	7	5	87.50	83.33	13.875	10.73	9.02	7.19
Sample 25	73	69	39	36	34	30	4.1	3.7	7	5	87.50	83.33	12.75	11.1	8.29	7.44
Mean	72	67.68	38.36	35.4	35.16	28.52	4.02	3.53	6.68	4.68	83.50	78.00	13.19	10.55	8.57	7.07
SD	2.45	2.01	1.47	1.88	1.71	1.77	0.23	0.21	0.47	0.47	5.83	7.77	0.64	0.65	0.42	0.44
CV%	3.40	2.98	3.82	5.30	4.87	6.20	5.72	5.92	6.98	9.97	6.98	9.97	4.87	6.20	4.87	6.20

SD - Standard deviation; CV - Coefficient of variation.

Table 2: Pearson correlation analysis of yield attributes to yield in blackgram during 2021 (No of plant samples N=25).

Yield attributes	X1	X2	X3	X4	X5	X6	X7	Y
X1	1	0.635**	0.782**	0.803**	0.402*	0.402*	0.782**	0.780**
X2		1	0.789**	0.394	0.753**	0.753**	0.789**	0.789**
X3			1	0.571**	0.465*	0.465*	1.000**	1.000**
X4				1	0.097	0.097	0.571**	0.570**
X5					1	1.000**	0.465*	0.465*
X6						1	0.465*	0.465*
X7							1	1.000**
Y								1

**: Correlation is significant at the 0.01 level (2-tailed).

*: Correlation is significant at the 0.05 level (2-tailed).

Table 3: Group statistics of yield attributes and yield in blackgram trials.

Yield attributes	Group variable (N=25)	Mean	Standard deviation	Std error Mean	T-test for equality of means (t -value)
X1	Demo	72.00	2.500	0.5000	6.673**
	Control	67.68	2.055	0.4118	
X2	Demo	38.36	1.497	0.2993	6.090**
	Control	35.40	1.914	0.3829	
X3	Demo	35.16	1.748	0.3497	13.210**
	Control	28.52	1.805	0.3611	
X4	Demo	4.02	0.234	0.0469	7.762**
	Control	3.53	0.213	0.0426	
X5	Demo	6.68	0.476	0.0952	14.852**
	Control	4.68	0.476	0.0952	
X6	Demo	83.50	5.951	1.1902	2.774**
	Control	77.99	7.932	1.5863	
X7	Demo	13.19	0.656	0.1311	14.063**
	Control	10.55	0.668	0.1336	
(Y)Yield q/ha	Demo	8.57	0.426	0.0853	12.142**
	Control	7.07	0.447	0.0895	

** t value is significant at the 0.01 level (2-tailed).

X1 - Germination %; X2 - Plant height (cm); X3 - No. of pods/plant; X4 - Pod length (cm); X5 - No. of seeds/pod; X6 - Pod filling %; X7 - Seed yield g/plant; Y - Yield q/ha; SD - Standard deviation; CV - Coefficient of variation.

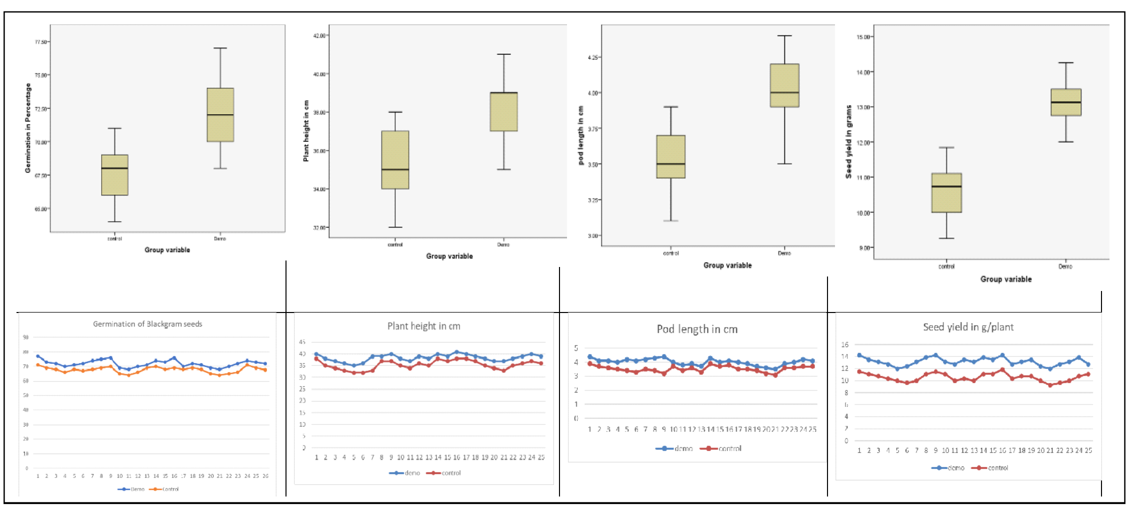

Fig 1: Observation on yield parameters on yield in demonstration plots of blackgram in 2021 (box plots and graphs).

Table 4: Evaluation of yield maximizing technologies in Blackgram through FLDs from 2018-19 to 2020-21(n=205).

Year	No. of demos	Area in hectares	Variety		Yield (q/ha)		Increase of yield over control (%)	Technology index (%)	Net returns (Rs/ha)		B:C ratio	
			Demo	Control	Demo	Control			Demo	Control	Demo	Control
2018-19	55	22	ADT 6, KKM 1, VBN 6	VBN 5, ADT 3	8.05	5.27	52.11	-1.90	62350	37500	2.61	2.02
2019-20	50	20	VBN 6 ADT 6	VBN 5, ADT 3	8.06	5.35	49.88	-1.96	68400	41100	2.75	2.1
2020-21	100	40	VBN 8	VBN 6, ADT 5	8.86	7.7	14.70	-12.09	70400	41700	2.78	2.09
Total	205	82		Average	8.32	6.11	38.90	-5.32	67050	40100	2.71	2.07

foliar spraying of Diammonium Phosphate (DAP), TNAU pulse wonder and 1% urea and 1% Potassium chloride (KCl) spray which enhanced yield (Table 4). Highest yield of 8.86 q/ha was recorded in 2020-21 with the introduction of new YMV resistant short duration synchronised maturing blackgram variety VBN 8 over the established YMV resistant variety VBN 6 (7.79 q/ha). This was possible with frontline demonstration of latest scientific blackgram technologies in farmers' field in a consistent way. Comparable results were published by Raj *et al*. (2013); Kumar and Wilson (2017); Umamageswari *et al*. (2019); Singh *et al.* (2023) and Amuthaselvi *et al*. (2023) in context of blackgram.

Technology index

Technology index was analysed by comparing the potential yield and demonstration yield of blackgram cultivars. It makes additional yield-maximizing technologies and high-yielding cultivars feasible for farmers to use in their farms. Higher is the feasibility when the technology index number is lower. The percentage-based technology index is impacted by the size of the technological divide. As values for the technology index increase, the lesser will be the rate of adoption of technologies in blackgram. The values for the technology index in demo plots ranged from -1.90 % to -12.09 % (average -5.32% in Table 4). Lower values of the technology index were recorded mainly due to continuous monitoring by scientists of KVK through FLD implementation, motivation of farmers in adopting yield maximizing technologies through trainings, extension programmes, field visits in addition to technical advice and critical inputs provided by the State Department and favourable climate and/or lesser pest and disease infestations through YMV resistant varieties. In the same line, research findings revealed by Saikia *et al.,* (2018) in blackgram and Bharti *et al*. (2024) in green gram.

Economics

The economic returns in the study depended mainly on farmers' yield in demo and control plots, cost of inputs utilized, wage rates of labor and existing market price fluctuations. Using, current input and output costs during the period of research, the economics of demo plot practices relative to farmer plot practices was computed. Table 4 clearly depicts higher average net returns (Rs. 67050/hectare) with average BCR 2.71 in demo plots compared to farmers plots (Rs. 40100/ha) average BCR 2.07. Alike conclusions stated by Saravanakumar *et al.* (2020), Natarajan *et al.* (2024) and Lalit *et al.* (2015) in blackgram, groundnut and greengram respectively.

CONCLUSION

The scientific study revealed clearly that an increase in yield of 38.90% was recorded by cultivating high yielding YMV resistant blackgram cultivars and adopting modern scientific technologies. A lower value of the technology index signifies the successful performance of yield-maximizing technologies in blackgram, fostering a positive relationship and confidence between farmers and extension officials. Additionally, yield attributes that directly impacted production included germination percentage, plant's height, pod number/plant, pod's length and per plant seed yield. These findings provided researchers with fresh insights into black gram cultivars suitable for rice fallow. In essence, the study underscores that in blackgram cultivation, the adoption of systematically implemented yield-maximizing technologies, coupled with high-yielding YMV-resistant varieties through field frontline demonstrations, can significantly enhance productivity per unit area with effective utilization of residual moisture in rice fallow conditions.

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Disclaimers

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Conflict of interest

The authors assure that the research was carried out as per Research ethics and that there is no conflict of interest involved.

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