Original Research Article

Effect of irrigation, varieties and nutrient management for improving the productivity of rice fallow black gram

ABSTRACT

Field experiments were conducted at Tamil Nadu Rice Research Institute, Aduthurai during rice fallow season 2013 and 2014 to evaluate the effect of irrigation, varieties and nutrient management for maximizing yield in rice fallow black gram. The experiments were laid out in split plot design with three replications. The main plot treatments comprised of irrigation (one supplemental irrigation at 25 DAS and no irrigation) and black gram varieties (ADT 3 and LBG 752) and nutrient management practices (Foliar spray of 2% DAP on 30 and 45 DAS, Pulse wonder at 5 kg/ha on 35 DAS and 1% 19:19:19 complex on 25 DAS *fb* 2% urea on 35 DAS, 2% urea phosphate on 35-40 DAS, soil application of DAP at 50 kg/ha to the standing paddy at the time of last irrigation and control) were assigned to sub plots. The results revealed that the rice fallow black gram given with one supplemental irrigation at 25 DAS recorded higher growth, yield attributes, yield, net return and BC ratio than no irrigation. Black gram variety LBG 752 registered higher plant height compared to ADT 3. However, yield attributes and yield were higher with ADT 3 whereas it was comparable with LBG 752. ADT 3 registered the highest net return and BC ratio than LBG 752. Foliar application of various nutrient sources performed similarly with respect to growth, yield attributes and yield of black gram. However, soil application of DAP 50 kg /ha during last irrigation to the standing paddy recorded higher net return and BC ratio followed by foliar application of 2% DAP on 30 and 45 DAS. Hence, black gram variety ADT 3 or LBG 752 given with one supplemental irrigation at 25 DAS followed by foliar application of 2% DAP at 30 and 45 DAS or soil application of DAP at 50 kg/ha to the standing paddy at the time of last irrigation could be recommended for getting higher productivity under rice fallow condition**.**

Key words: Rice fallow black gram, irrigation, varieties, nutrient management, yield, economics

INTRODUCTION

Black gram (*Vigna mungo* L.) is a widely grown grain legume and assumes considerable importance from the point of food and nutritional security in the world. Black gram is favorable short duration pulse crop as it thrives better in all seasons either as sole or as intercrop or rice fallow crop. India is the world's largest producer as well as consumer of black gram. In India, it occupies 12.7% of total area under pulses and contributes 8.4% of total pulses production.

Black gram is one of the important pulse crops in Tamil Nadu which is grown under irrigated, rainfed and rice-fallow conditions (Ramesh and Rathika, 2016). Pulses are sown under rice fallow condition in about 2.6 lakh hectares in Tamil Nadu which is 30.8% of the total area under pulses in this state. The rice fallow pulses are cultivated in Thiruvarur, Thanjavur, Nagapattinam Districts and some parts of Pudukottai, Trichi and Cuddalore Districts in Cauvery Delta Zone with an average productivity of 204 kg/ha. In the residual soil moisture of the Cauvery Delta soils, pulses particularly black gram and green gram are broadcasted 7 to 10 days before the harvest of paddy and allowed to germinate and grow. Since pulses are grown under paddy stubbles, the pulse crops have to survive in the residual moisture of the soil. Besides, supplemental irrigation during the period will also provide all comfort to grow well and yield within 65 to 70 days of sowing. ADT 3 is most common variety for black gram in the canal dependent samba rice area of the Cauvery Delta where the soil is heavy clayey in nature. A new black gram variety LBG 752 which is resistant to YMV and escapes terminal moisture stress predominantly grown in Andra Pradesh during rice fallow season needs to be tested in the Cauvery Delta Zone of Tamil Nadu. Among the various factors, non-application of nutrients is also one of the important factors causes poor yield in rice fallow black gram. Presently, foliar spray is the way to mitigate the nutrient stress and to maximize the rice fallow black gram yield.

Keeping these in view, the present study was undertaken to evaluate the effect of irrigation, varieties and nutrient management for maximizing yield in rice fallow black gram.

MATERIALS AND METHODS

Field experiments were conducted at Tamil Nadu Rice Research Institute, Aduthurai during rice fallow season 2013 and 2014 to evaluate the effect of varieties, supplemental irrigation and nutrient management practices for maximizing yield in rice fallow black gram. The soil of the experimental field was alluvial clay with pH of 7.5 and EC of 0.3 dS/m. The experimental soil was low, high and medium in available nitrogen, phosphorus and potassium

contents, respectively. The experiments were laid out in split plot design with three replications. The main plot treatments comprised of irrigation (one supplemental irrigation at 25 DAS and no irrigation) and black gram varieties (ADT 3 and LBG 752) and nutrient management practices (Foliar spray of 2% DAP on 30 and 45 DAS, Pulse wonder at 5 kg/ha on 35 DAS and 1% 19:19:19 complex on 25 DAS *fb* 2% urea on 35 DAS, 2% urea phosphate on 35-40 DAS, soil application of DAP at 50 kg/ha to the standing paddy at the time of last irrigation and control) were assigned to sub plots.

Observations on growth and yield parameters of black gram *viz*., plant height, numbers of pods/plant, number of seeds/pod and 100 seed weight were recorded. Grain yield was recorded at the time of harvest from the net plot area and expressed as kg/ha. Economics of different treatments were worked out by using the current market price of inputs and black gram grain. All the recorded data were analyzed statistically as per the method suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect on plant height

The plant height was significantly higher in rice fallow black gram given with one supplemental irrigation at 25 DAS as compared to no irrigation at all the stages during both the years. Increased available soil moisture due to supplemental irrigation favoured higher plant height. This is in conformity with the findings of Sheoran *et al.* (2001).

Between black gram varieties, LBG 752 registered taller plants than ADT 3 at all the stages during both the years. The mean plant height was 54.5 cm in LBG 752 and 49.7 cm in ADT 3 black gram at harvest. The variation in plant height might be due to different varietal characters. This is in agreement with the findings of Verma *et al.* (2011) and Rathika and Ramesh (2018).

Among the nutrients tested, there was no significant difference on plant height was observed on 20 DAS during both the years. However, significantly taller plants were noticed under nutrient management practices over no nutrient application at 40 DAS and harvest. However, all the nutrient management practices produced comparable plant height during both the years. This is in line with the findings of Ganapathy *et al.* (2008).

Effect on yield parameters

Application of one supplemental irrigation and nutrient management practices significantly influenced the yield attributes of rice fallow black gram.

Rice fallow black gram given with one supplemental irrigation on 25 DAS produced more number of pods/plant (22) and 100 seed weight (4.0 g) over no irrigation. Supplemental irrigation during vegetative stage improved the crop growth, reduced the flower dropping and favoured more number of pods/plant and better grain filling. The number of seeds/pod was not varied significantly among the irrigation levels. This is in line with the findings of Sekhon *et al.* (1994) and Rathika *et al.* (2020).

Black gram varieties ADT 3 and LBG 752 produced comparable yield attributes *viz.*, number of pods/plant, seeds/pod and 100 seed weight during both the years and pooled data. Non significant effect of varieties on yield attributes in black gram was also reported by Biswas *et al.* (2002).

The effect of various nutrient management practices on yield attributes were similar and produced comparable yield attributes such as number of pods/plant, seeds/pod and 100 seed weight. However, this was significantly superior over no nutrient application. Application of DAP to preceding rice favoured better growth characters of black gram followed by foliar spray of DAP and KCl during flowering stage improved the photosynthetic efficiency, reduced flower dropping and increased seed setting which in turn favoured higher yield parameters of black gram. Farmers' practice of without nutrients application registered significantly lesser number of pods than other treatments. This is in agreement with the findings of Ganapathy *et al.* (2008) and Ramesh *et al.* (2016).

Effect on grain yield

The effect of irrigation and nutrient management practices showed significant influence on the grain yield of rice fallow black gram during both the years.

Application of one supplemental irrigation on 25 DAS to rice fallow black gram recorded significantly higher grain yield of 748 kg/ha as compared to no irrigation (642 kg/ha). The yield increment was 16.5 per cent underone supplemental irrigation on 25 DAS over no irrigation. This might be due to that increased moisture availability resulted in increased plant height, more

number of pods/plant and 100 seed weight of rice fallow black gram. This is in agreement with the findings of Siddique *et al.* (2004) and Senthil Kumar *et al.* (2017)

Between varieties tested, there was no significant variation in grain yield of black gram. However, ADT 3 black gram registered numerically higher grain yield than LBG 752 during both the years. The black gram variety LBG 752 may be recommended as alternate to ADT 3 black gram under rice fallow situation in the Cauvery Delta region. The black gram variety LBG 752 is resistant to Yellow Mosaic Virus (YMV) disease which is also a serious problem in the rice fallow black gram. The highest grain yield of variety may be due to higher pods per plant, seeds per pod and 100 seed weight. These favorable phenomenon resulted in highest yield. The finding on variation in yield of different varieties is in agreement with the result reported by Miah *et al.* (2009) and Rathika and Ramesh (2018).

Foliar spray of 2% DAP on 30 and 45 DAS produced higher grain yield of 728 kg/ha followed by soil application of DAP at 50 kg/ha to the standing paddy at the time of last irrigation registered grain yield of 722 kg/ha. However, this was on par with each other nutrient management *viz.,* foliar spray of 2% urea phosphate on 35-40 DAS, 1% 19:19:19 complex on 25 DAS *fb* 2% urea on 35 DAS and pulse wonder at 5 kg/ha on 35 DAS and produced grain yield of 715, 709 and 693 kg/ha. Application of DAP to preceding rice in last irrigation might have dissolved completely and made available to black gram seedlings resulted in better growth and yield. This might be due to supplementation of nutrients at the critical stage and foliar application of nutrients coupled with enhanced the number of floral buds, prevented the floral shedding by maintaining optimum bio-physiological conditions in plants which resulted in significant improvement in yield parameters like number of pods per plant and test weight as compared to rest of treatments. The findings in the present study are in conformity with the findings of Ramesh *et al.* (2016) and Dayana *et al.* (2021). The minimum grain yield of 602 kg/ha was recorded under farmers' practice of without nutrient application.

Effect on economics

Economic analysis of supplemental irrigation, varieties and nutrient management practices in rice fallow black gram revealed that there was positive response in net returns and benefit cost ratio.

The rice fallow black gram given with one supplemental irrigation at 25 DAS gave the highest net return and BC ratio (Rs. 17955/ha and 2.47) during both the years than no irrigation. One supplemental irrigation at 25 DAS gave additional net return of Rs. 4200/ha. Higher grain yield due to supplemental irrigation was the reason for higher economics of rice fallow black gram.

Among the varieties, ADT 3 registered the highest net return and BC ratio in both the years than LBG 752. ADT 3 registered mean net return and BC ratio of Rs.16355/ha and 2.39. Because of variable yields from different varieties, the variable net income was observed.

Among the nutrient management practices, soil application of DAP at 50 kg/ha to the standing paddy at the time of last irrigation registered higher net return and BC ratio of Rs. 15755/ ha and 2.21 respectively. This was closely followed by foliar spray of 2% DAP on 30 and 45 DAS and 2% urea phosphate on 35 DAS. Foliar spray of 2% DAP twice incurred more labour cost as compared to soil application of DAP was the reason for higher net returns and BC ratio under this treatment. Foliar spray to rice fallow black gram coincides with summer season, non availability of water for spraying is common problem in Cauvery Delta region. Hence, application of DAP at 50 kg/ha to the standing paddy at the time of last irrigation can be recommended as an alternate nutrient management strategy to rice fallow black gram. However, foliar spray of 2 % DAP twice or 2% urea phosphate on 35DAS can be practiced wherever the water and labour are available. Ramesh *et al.* (2016) reported that the treatments which received foliar spray of nutrients registered lesser BCR mainly due to higher spraying cost over other treatments.

CONCLUSION

From the study it could be concluded that black gram variety ADT 3 or LBG 752 given with one supplemental irrigation at 25 DAS followed by foliar application of 2% DAP at 30 and 45 DAS or soil application of DAP at 50 kg/ha to the standing paddy at the time of last irrigation could be recommended for getting higher productivity under rice fallow condition**.**

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Table 1. Effect of irrigation, varieties and nutrient management on plant height of rice fallow black gram

Treatments	Plant height (cm)								
	2013			2014			Pooled		
	20 DAS	40 DAS	At harvest	20 DAS	40 DAS	At harvest	20 DAS	40 DAS	At harvest
Irrigation levels									
M_1 - One supplemental irrigation at 25 DAS	25.3	44.8	56.8	21.1	41.2	52.3	23.1	46.6	54.2
M_2 - No irrigation	24.8	40.5	50.6	20.3	39.1	48.5	22.6	43.1	49.0
SEd	0.6	1.5	1.7	0.7	1.5	1.5	0.5	1.4	1.8
CD (P=0.05)	NS	2.9	3.5	NS	3.2	3.2	NS	3.0	3.7
Varieties									
V_1 - ADT 3	24.2	44.2	51.4	20.4	42.0	47.9	22.2	46.0	49.7
V_2 - LBG 752	25.9	46.7	55.8	22.9	46.3	53.2	24.9	48.6	54.5
SEd	0.8	1.1	1.4	0.9	1.0	1.3	0.8	1.0	1.5
CD (P=0.05)	1.6	2.2	2.8	2.0	2.2	2.6	1.8	2.2	3.0
Nutrient management									
S_1 - Foliar spray of 2 % DAP on 30 & 45 DAS	25.0	45.7	56.8	22.3	42.4	53.2	24.5	47.5	54.0
S_2 - Foliar spray of pulse wonder @ 5 kg /ha on 35 DAS	25.3	43.5	53.6	22.0	42.0	50.3	24.3	47.1	51.6
S_3 - Foliar spray of 1% 19:19:19 complex on 25 DAS *fb* 2% urea on 35DAS	25.4	45.0	55.4	22.1	42.1	52.9	24.1	47.0	53.8
S_4 - Foliar spray of 2% urea phosphate on 35 DAS	25.2	45.3	54.8	22.2	42.2	50.5	24.2	47.4	52.2
S_5 - Application of DAP @ 50 kg/ha to the standing paddy at the time of last irrigation	25.8	45.8	56.9	22.5	43.2	53.3	24.7	47.9	55.0
S_6 - Control	24.9	38.9	46.3	23.3	40.3	44.1	23.9	40.5	42.8
SEd	0.6	1.4	2.0	0.7	1.2	1.8	0.8	1.2	2.2
CD (P=0.05)	NS	2.2	4.0	NS	2.6	3.7	NS	2.6	4.0

Interaction absent

Table 2. Effect of irrigation, varieties and nutrient management on yield attributes of rice fallow black gram

Treatments	No. of pods/plant			No. of seeds/pod			100 seed weight (g)		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
Irrigation levels									
M_1 - One supplemental irrigation at 25 DAS	22	21	22	6.8	6,5	6.7	4.2	3.9	4.0
M_2 - No irrigation	19	17	18	7.0	6.7	6.9	3.8	3.6	3.5
SEd	0.7	0.9	1.1	0.3	0.4	0.4	0.1	0.1	0.2
CD (P=0.05)	1.4	1.8	2.3	NS	NS	NS	0.2	0.3	0.4
Varieties									
V_1 - ADT 3	21	20	19	6.8	6.5	6.6	3.8	3.5	3.6
V_2 - LBG 752	20	19	17	7.1	6.6	6.9	4.0	3.8	3.9
SEd	0.7	0.8	1.0	0.2	0.1	0.2	0.2	0.2	0.2
CD (P=0.05)	1.4	1.7	2.0	NS	NS	NS	NS	NS	NS
Nutrient management									
S_1 - Foliar spray of 2 % DAP on 30 & 45 DAS	22	20	21	7.0	6.8	6.9	4.1	4.0	3.8
S_2 - Foliar spray of pulse wonder @ 5 kg /ha on 35 DAS	21	17	19	6.7	6.6	6.7	3.7	3.7	3.5
S_3 - Foliar spray of 1% 19:19:19 complex on 25 DAS *fb* 2% urea on 35DAS	21	18	20	7.0	6.8	6.9	3.9	3.8	3.6
S_4 - Foliar spray of 2% urea phosphate on 35 DAS	21	17	19	6.8	6.5	6.7	3.9	3.6	3.6
S_5 - Application of DAP @ 50 kg/ha to the standing paddy at the time of last irrigation	21	22	21	6.9	6.7	6.6	4.0	3.9	3.7
S_6 - Control	18	14	16	6.7	6.5	6.5	3.5	3.0	3.3
SEd	0.8	1.1	1.1	0.4	0.3	0.3	0.2	0.3	0.1
CD (P=0.05)	1.6	2.2	2.1	NS	NS	NS	0.4	0.5	0.3

Interaction absent

Table 3. Effect of irrigation, varieties and nutrient management on yield of rice fallow black gram

Treatments	Grain yield (kg/ha)		
	2013	**2014**	**Pooled**
Irrigation levels			
M_1 - One supplemental irrigation at 25 DAS	768	742	748
M_2 - No irrigation	659	633	642
SEd	24	26	23
CD (P=0.05)	47	52	46
Varieties			
V_1 - ADT 3	736	694	712
V_2 - LBG 752	697	665	672
SEd	23	28	26
CD (P=0.05)	NS	NS	NS
Nutrient management			
S_1 - Foliar spray of 2 % DAP on 30 & 45 DAS	745	708	728
S_2 - Foliar spray of pulse wonder @ 5 kg /ha on 35 DAS	702	684	693
S_3 - Foliar spray of 1% 19:19:19 complex on 25 DAS *fb* 2% urea on 35DAS	725	690	709
S_4 - Foliar spray of 2% urea phosphate on 35 DAS	737	692	715
S_5 - Application of DAP @ 50 kg/ha to the standing paddy at the time of last irrigation	742	702	722
S_6 - Control	625	594	602
SEd	22	24	22
CD (P=0.05)	43	48	44

Interaction absent

Table 4. Effect of irrigation, varieties and nutrient management on economics of rice fallow black gram

Treatments	Net return (Rs./ha)			BC ratio		
	2013	2014	Mean	2013	2014	Mean
Irrigation levels						
M_1 - One supplemental irrigation at 25 DAS	19000	16910	17955	2.62	2.32	2.47
M_2 - No irrigation	14600	12910	13755	2.29	2.04	2.17
Varieties						
V_1 - ADT 3	17720	14990	16355	2.51	2.27	2.39
V_2 - LBG 752	16660	14030	15345	2.38	2.18	2.28
Nutrient management						
S_1 - Foliar spray of 2 % DAP on 30 & 45 DAS	16360	14830	15595	2.22	2.10	2.16
S_2 - Foliar spray of pulse wonder @ 5 kg /ha on 35 DAS	15040	13875	14458	2.15	2.06	2.11
S_3 - Foliar spray of 1% 19:19:19 complex on 25 DAS *fb* 2% urea on 35DAS	15565	14530	15048	2.16	2.11	2.14
S_4 - Foliar spray of 2% urea phosphate on 35 DAS	16200	14350	15275	2.22	2.08	2.15
S_5 - Application of DAP @ 50 kg/ha to the standing paddy at the time of last irrigation	16580	14930	15755	2.27	2.14	2.21
S_6 - Control	12720	10430	11575	1.93	1.77	1.85

Data not statistically analyzed.