Original Research Article

Influence of sowing methods and time on growth, yield and yield attributes of blackgram under rice fallow blackgram cropping system

Abstract

Aim: Black gram is one of the most important pulse crops raised in all types of soil with well drained conditions irrespective of season. It is cultivated as pure crop, intercrop as well as rice fallow crop in southern India. In general, the production and productivity of blackgram is getting declined owing to poor management practices that too in rice fallow blackgram. Hence the study was undertaken involving rice establishment methods as one of the strategies which determine the availability of residual moisture essential for establishment of rice fallow blackgram during its early stage.

Study design: The experiment was laid out in Split-split plot design with three factors in combination of nine treatments and it was replicated thrice.

Place and Duration of Study: A field investigation was carried out at Agricultural College and Research Institute, Madurai (Tamil Nadu Agricultural University), Tamil Nadu, India during September 2019 – April 2020

Methodology: To evaluate the impact of methods and time of sowing on rice fallow blackgram**.** The factors involve establishment methods of rice as main plot, methods of sowing of rice fallow blackgram as sub plot and time of sowing of rice fallow blackgram laid out in sub-sub plot treatment.

Results: The above-mentioned treatments had the best growth qualities, growth analysis, and yield. It might be owing to increased residual moisture content in the above-mentioned combinations, which resulted in higher germination percentage, better crop stand, and higher growth and yield of rice fallow blackgram.

Conclusion: Sowing blackgram in rice fallow situations with a rice fallow pulse planter 10 days before rice harvest underneath the rice establishment methodology of a drum seeder is the optimum management approach.

Key words: Method, Time, Sowing, Establishment, Blackgram

Introduction

Pulse crops have an integral role in human nutrition. considered as the chief source of proteins compared to other protein sources like meat and meat products. The United Nations declared 2016 as "International Year of Pulses" (IYP) to reinforce public awareness of nutritional benefits of pulses as part of sustainable food production aimed at food security and nutrition (Mohanty *et al.*, 2015). Among the global statistics, India is the largest producer (25%), consumer (27%) and importer (14%) of the pulses in the world. In India black gram was grown majorly under south Indian states and also grown in some parts of northern states

where in semi-arid climate prevails. In Tamil Nadu, the production under pulses is 5.56 lakh tonnes obtained from an area of 8.24 lakh hectares with productivity of 675 kg ha^{-1} during 2017-18. Whereas, under blackgram the area is 4.26 lakh hectares with a production of 3.016 lakh tonnes and productivity of 707 kg ha^{-1} during 2019-2020 (Govt. of Tamil Nadu, 2020).

Being a proteinaceous legume crop, its demand is increasing as India's population grows and also increasing demand due to its use of house hold purposes for making variety of south Indian breakfast dishes. As a result, it's also known as "poverty meat". Since farmers started cultivation of rice, growing legumes in rice-fallows has also been under practice in wetland ecosystem.

Short-season pulses may be grown with the leftover moisture left in the soil after rice harvest. (Pande, 2012). If planted in the existing fallow region, pulses would improve the soil fertility quality by fixing atmospheric nitrogen and supplying organic matter. (Mukesh Choudhary *et al.,* 2014). Relay cropping may aid in determining the optimum time of sowing for the following crop after rice, as well as favouring early ground cover to prevent evaporative loss. (Sharma *et al.,* 2014, Kumar *et al.,* 2019). Under relay cropping, rice fallow pulses contribute 40-50 per cent of total pulse production, of which major share by black gram. Practice of relay cropping decreases cost of production, as it need no land preparation and other field operations. Unlike other crops, rice fallow pulses do not require irrigation, weed and nutrient management excluding sowing and harvesting. In fact, rice fallow pulse is a boomerang to the wetland rice growers as they could able to fetch more income with less management and input cost (Mahapatra, 1975).

Time of sowing is the utmost important agronomic factor for realizing yield potential of improved varieties in rice fallow pulses; which helps in achieving complete synchronization between vegetative and reproductive stages of crop and also obtaining high seed yields (Rathore *et al.,* 2010). In addition, methods of sowing were also one of the needy operations to get better revenue from agriculture. Broadcasting in rice fallow pulses causes many constraints like uneven distribution of seeds at shallow depth and loss of moisture after rice harvest which leads to poor contact between seeds and soil, low germination, more weed growth, unhealthy plant and lower yields.

The research findings available are very few in pulses, especially on methods and time of sowing which are vital as far as germination, emergence and establishment during its early stage and are found to be very poor in rice fallow black gram than normal system of cultivation. In order to effective utilization of residual moisture besides other resources like light, space and nutrients, placing the seeds at proper spacing and at optimum depth is vital as to enhance growth, development and yield of crop. As sowing seeds at proper spacing by manual means in standing crop condition is technically not feasible and economically not viable in rice fallow pulse, machine sowing would offer a coping mechanism to accomplish the situation. Keeping in view, the study was undertaken in rice fallow pulse under different establishment methods of rice in combination with different methods and time of sowing.

Materials and Methods

A field experiment was conducted at Agricultural College and Research Institute, Madurai (Tamil Nadu Agricultural University) Tamil Nadu, India, during September 2019 – April 2020 to study the influence of methods and time of sowing on growth attributes, yield and yield attributes of Rice fallow Black gram under different rice establishment methods in wetland eco-system. The experiment was laid out in split-split plot design with three factors combination of nine treatments and was replicated thrice. The main plot (Establishment methods of rice) consists of M_1 – Line planting by manual method, M_2 – Sowing by drum

seeder and M_3 – Transplanting by machine, the sub plot (Methods of sowing of rice fallow blackgram) imposed with S_1 – Sowing by rice fallow pulse planter, S_2 – Random dibbling by manual method and S_3 –Sowing by broadcasting (Farmer's practice) and Sub-sub plot (Time of sowing of rice fallow blackgram) were T_1 – 10 days before rice harvest, T_2 – 7 days before rice harvest and T_3 – One day after rice harvest.

Black gram variety ADT 6 was chosen as test crop for the study. The seeds were sown as per the treatment schedule. Rice was hand harvested and their residues were allowed as a part of the continuous rice fallow black gram rotation experiment. Observations were recorded on soil moisture, growth attributes, growth analysis, yield and yield attributes. The data pertaining to critical difference were worked out at 5 per cent probability level $P \leq 0.05$ and non-significant values were denoted as NS.

Results and Discussion

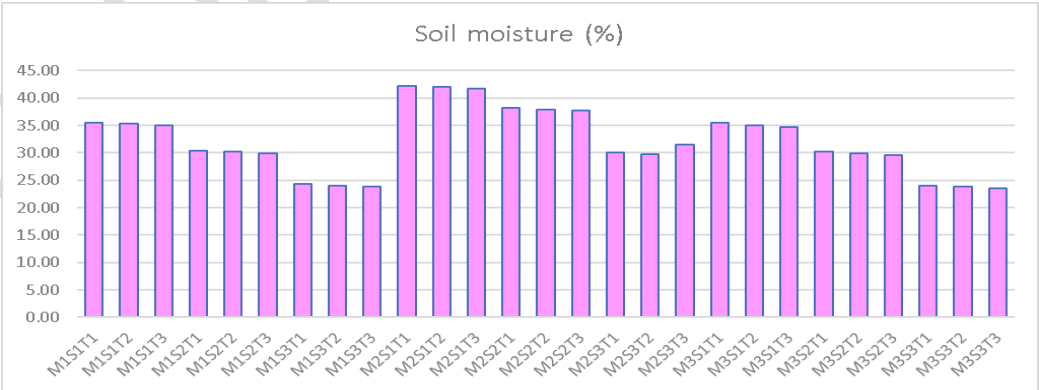
Soil moisture (%)

In rice establishment methods, sowing by drum seeder (M_2) registered distinctly highest soil moisture (36.77 %) at the time of sowing blackgram under rice fallow conditions (Fig.1). While the lowest soil moisture (29.55 %) was observed in the rice establishment method of machine transplanting (M_3). Geetha and Velayutham (2009) reported that the rice fallow pulse relies entirely on moisture and nutrients left over from the previous rice crop to survive.

Under different methods of sowing, it gave significant impact on soil moisture at the time of sowing of blackgram with rice fallow pulse planter (S_1) recorded the highest soil moisture of 37.42 %. Whereas, sowing by broadcasting (S_3) recorded the lowest soil moisture (26.08 %) under fallows. The crop cultivated in the rice fallow systems thrives solely on the residual moisture and available soil nutrients left over (Rao, 2011).

In case of different time of sowing of blackgram (RFB) and also in combination of three factors it gave non-significant impact on soil moisture.

Fig. 1. Effect of methods and time of sowing and rice establishment methods on soil moisture (%) of rice fallow blackgram



Germination percentage

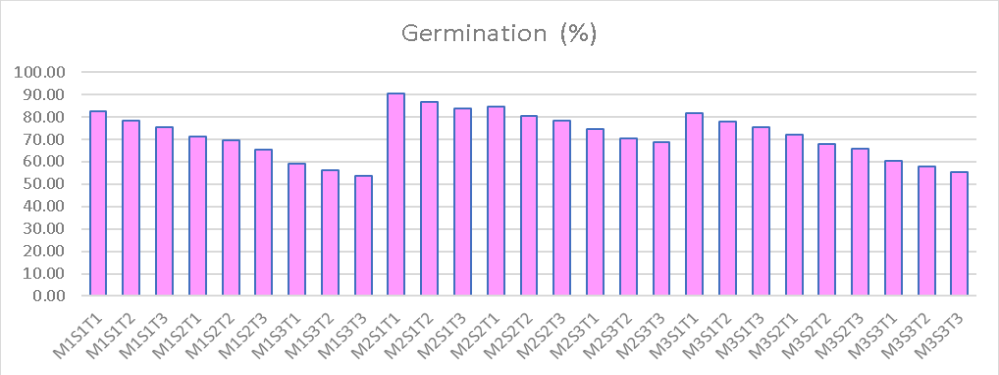
From Fig. 2, the rice establishment methods, sowing by drum seeder (M_2) recorded distinctly highest germination (79.81 %). Whereas the lowest germination (68.00 %) were recorded in the manual transplanting of rice establishment method(M_2).

The highest germination of 81.42 % was noted in sowing of blackgram with rice fallow pulse planter (S_1) and lowest germination of 61.84 % in broadcasting (S_3) method under different methods of sowing as rice fallow situations. Only 1.54 and 1.46 lakh plants ha^{-1} were found in blackgram broadcasting beneath stubble mulch, respectively (Kavitha and Wahab, 2001). They have also reported that blackgram dibbling in rice with intact stubbles and stubble mulch greatly aided germination and resulted in a higher population of 217 and 213 lakh plants ha^{-1}.

As for different timing, it gave significant impact on germination (%). At 10 days before harvesting of rice (T_1) recorded the maximum germination (75.22 %), whereas consistently lowest germination (69.19 %) was recorded at 1 day after harvesting rice (T_3).

There was no interaction effect in between the treatments on germination (%) of blackgram.

Fig. 2. Effect of methods and time of sowing and rice establishment methods on germination (%) of rice fallow blackgram



Growth attributes

Of the various rice establishment methods, sowing by drum seeder (M_2) reached distinctly highest plant height (43.24 cm), LAI (1.63) and DMP (1686.20 kg ha^{-1}) at harvest stage. (Table.1). While the lowest plant height (37.31), LAI (1.38) and DMP (1231.98) were obtained in the rice establishment method of machine transplanting (M_3).

Sowing of blackgram with rice fallow pulse planter (S_1) achieved maximum plant height, LAI and DMP. Whereas, it was found to be lower under broadcasting method of sowing (S_3) in various methods of sowing. Pandian *et al.* (2001) reported that dibbling of green gram seeds with mulch produced significantly higher LAI of 3.94.

With regard to different time of sowing, sowing blackgram (RFB) at 10 days before harvesting of rice (T_1) produced the highest plant height, LAI and DMP at harvest. Whereas, consistently lowest plant height, LAI and DMP produced in sowing rice fallow blackgram (RFB) at 1 day after harvesting rice (T_3). Similar results were also detected by Maruthupandi *et al.* (2016) and Dasharath Prasad *et al.* (2012) in LAI of rice fallow blackgram sowing at 10 days before harvesting of rice. Gulab Singh Yadav *et al.* (2018) described plant height, LAI and DMP were observed highest in early sowing (25th November) compared with delayed sowing (15th December) of Lentil in rice fallow lands.

Although studying the interaction effect, rice establishment method of sowing by drum seeder in combination with blackgram sowing by rice fallow pulse planter at 10 days before harvesting of rice ($M_2S_1T_1$) recorded the highest plant height (55.52 cm), LAI (2.13) and DMP (2236.90 kg ha^{-1}). It was followed by rice establishment method of sowing by drum seeder in combination with blackgram sowing by rice fallow pulse planter at 7 days before harvesting of rice ($M_2T_2S_1$). However, the lowest plant height (30.80 cm), LAI (1.12) and DMP (731.78 kg ha^{-1}) at harvest stage was noticed in rice establishment method by machine transplanting in combination with sowing of blackgram broadcasting at 1 day after harvesting of rice ($M_3S_3T_3$). Chickpea seeded on December 1 produced the highest plant height. Sowing on December 20 gave a lower value. This might be due to improved source and sink relationships as well as higher growth attributes. (Kabir *et al.,* 2009).

Table 1. Effect of methods and time of sowing and rice establishment methods on plant height (cm), LAI and DMP (kg ha^{-1}) of rice fallow blackgram (RFB) at harvest

Establishment method of Rice	Method of sowing RFB	Time of sowing			Mean	Time of sowing			Mean	Time of sowing			Mean
		RFB on Plant height at Harvest				RFB on LAI at Harvest				RFB on DMP at Harvest			
		T_1	T_2	T_3		T_1	T_2	T_3		T_1	T_2	T_3	
M_1	S_1	44.46	43.09	38.91	42.45	1.64	1.68	1.57	1.63	1403.48	1378.73	1376.49	1386.23
	S_2	39.34	44.31	43.95	42.53	1.54	1.58	1.53	1.55	1498.62	1480.14	1358.27	1445.67
	S_3	38.74	38.94	39.42	39.03	1.47	1.42	1.40	1.43	1264.20	1362.12	856.02	1160.78
Mean		40.84	42.11	40.76	41.24	1.55	1.56	1.50	1.53	1388.77	1406.99	1196.93	1330.90
M_2	S_1	55.52	48.80	44.83	49.71	2.13	1.69	1.59	1.80	2236.90	2080.67	1581.26	1966.27
	S_2	45.69	38.57	41.66	41.97	1.77	1.54	1.55	1.62	1982.70	1750.00	1371.30	1701.33
	S_3	39.25	39.38	35.50	38.04	1.59	1.49	1.38	1.49	1391.48	1525.97	1255.55	1391.00
Mean		46.82	42.25	40.66	43.24	1.83	1.57	1.51	1.63	1870.36	1785.54	1402.70	1968.20
M_3	S_1	45.66	34.41	34.24	38.10	1.66	1.40	1.34	1.47	1566.31	1406.50	1216.00	1396.27
	S_2	43.08	37.78	33.22	38.02	1.60	1.36	1.21	1.39	1244.57	1481.34	1127.16	1284.35
	S_3	38.68	37.97	30.80	35.81	1.44	1.30	1.12	1.28	1106.08	1208.09	731.78	1015.32
Mean		42.47	36.72	32.75	37.31	1.57	1.35	1.22	1.38	1305.65	1365.31	1024.98	1231.98
	SEd		**CD (P=0.05)**			**SEd**		**CD (P=0.05)**		**SEd**		**CD (P=0.05)**	

M	0.48	0.98	0.016	0.033	48.40	134.39
S	0.55	1.21	0.027	0.060	20.58	44.85
T	1.19	3.03	0.039	0.098	30.73	62.33
MS	1.26	3.20	0.050	0.121	56.48	147.86
MT	0.84	1.70	0.028	0.057	65.05	158.89
ST	1.45	2.95	0.056	0.118	48.09	98.87
MST	0.98	2.72	0.031	0.087	80.71	165.29

Growth analysis

Crop growth rate (CGR)

Among the rice establishment methods, sowing by drum seeder (M_2) registered numerically more in CGR at 60 DAS - harvest in blackgram (Table.2). While, lowest CGR was obtained in the rice establishment method of machine transplanting (M_3).

Sowing blackgram with rice fallow pulse planter (S_1) recorded the highest CGR. While in broadcasting (S_3) it obtained lowest CGR under several method of sowing.

In the case of different time of sowing, sowing at 10 days before harvesting of rice (T_1) produced the highest CGR at 60 DAS – harvest. Whereas, consistently lowest CGR recorded at 1 day after harvesting rice (T_3).

There was no interaction between the treatments on CGR at 60 DAS - harvest.

Relative growth rate (RGR)

There was no significant difference between the treatments of rice establishment methods on RGR at 60 DAS - harvest in blackgram in fallows (Table.3).

Under different methods of sowing of blackgram, it gave significant impact on RGR. Meanwhile, sowing blackgram with rice fallow pulse planter (S_1) reached the highest RGR. Whereas, in broadcasting (S_3) method recorded the lowest RGR at 60 DAS - harvest.

Sowing blackgram (RFB) at 10 days before harvesting of rice (T_1) reached the highest RGR at 60 DAS – harvest. Whereas, consistently lowest RGR in sowing rice fallow blackgram (RFB) at 1 day after harvesting rice (T_3) under time of sowing.

While studying the interaction effect, rice establishment method of sowing by drum seeder in combination with blackgram sowing in rice fallows by rice fallow pulse planter at 10 days before harvesting of rice ($M_2S_1T_1$) recorded the highest RGR. However, the lowest RGR at 60 DAS-harvest stage was noticed in rice establishment method by machine transplanting in combination with sowing of blackgram by broadcasting at 1 day after harvesting of rice ($M_3S_3T_3$).

Table 2. Effect of methods and time of sowing and rice establishment methods on CGR, RGR of rice fallow blackgram (RFB) at 60 DAS - Harvest

Treatment	CGR at 60 DAS - Harvest	RGR at 60 DAS - Harvest
Main - Establishment method of Rice		
M_1- Line planting by manual method	0.579	0.0037
M_2- Sowing by drum seeder	0.609	0.0038
M_3- Transplanting by machine	0.512	0.0038
SEd	0.0092	0.00005
CD (P=0.05)	0.025	NS
Sub - Method of sowing RFB		
S_1- Sowing by rice fallow pulse planter	0.603	0.0035

S_2- Random dibbling by manual method	0.554	0.0034
S_3- Sowing by broadcasting (Farmer's practice)	0.542	00044
SEd	0.0096	0.00004
CD (P=0.05)	0.021	0.00010
Sub-sub - Time of sowing of RFB		
T_1- 10 days before rice harvest	0.590	0.0034
T_2-7 days before rice harvest	0.571	0.0037
T_3- One day after rice harvest	0.538	0.0042
SEd	0.010	0.00006
CD (P=0.05)	0.217	0.00012
Interaction (SEd)	0.029	0.00019
Interaction CD (P=0.05)	NS	0.00033

Yield parameters

As for rice establishment methods, sowing rice by drum seeder (M_2) recorded distinctly highest seed and haulm yield (421.07 and 1471.22 kg ha^{-1} respectively). While, lowest seed and haulm yield (279.32 and 1102.00 kg ha^{-1} respectively) was observed in rice establishment method by machine transplanting (M_3) (Table.3).

As such, sowing of blackgram with rice fallow pulse planter (S_1) recorded the highest seed and haulm yield. Whereas, sowing by broadcasting (S_3) recorded the lowest seed and haulm yield. Similar results were also reported by Sasikala *et al*., (2014) who obtained higher seed yield of 1207 kg ha^{-1} rice fallow blackgram in sowing by line dibbling compared to sowing by broadcasting (247 kg ha^{-1}).

In the case of time of sowing, blackgram sowing at 10 days before rice harvest (T_1) recorded the highest seed and haulm yield. Whereas, these were consistently lower at 1 day after rice harvest (T_3). Similar results were made by Rakesh Kumar *et al.* (2015) who reported that the seed yield increased with early sowing (5^{th} April) of green gram. While, yield decreased with late sowing (April 15).

As for as interaction effect of treatments, the rice establishment method of sowing by drum seeder in combination with rice fallow blackgram sowing by rice fallow pulse planter at 10 days before harvesting of rice ($M_2S_1T_1$) produced the highest seed and haulm yield (714.90 and 1802.33 kg ha^{-1} respectively). It was followed by rice establishment method of sowing by drum seeder in combination with rice fallow blackgram sowing by rice fallow pulse planter at 7 days before harvesting of rice ($M_2T_2S_1$). However, the lowest seed and haulm yield (121.02 and 697.33 kg ha^{-1} respectively) were observed in rice establishment method by machine transplanting in combination with rice fallow blackgram (RFB) sowing by broadcasting at 1 day after harvesting of rice ($M_3S_3T_3$).

Table 3. Effect of methods and time of sowing and rice establishment methods on Seed and Haulm yield (kg ha^{-1}) of rice fallow blackgram (RFB)

Establishment method of Rice	Method of sowing RFB	Time of sowing			Mean	Time of sowing			Mean
		RFB on seed yield				RFB on haulm yield			
		T_1	T_2	T_3		T_1	T_2	T_3	
M_1	S_1	386.16	353.69	324.16	354.67	1190.66	1193.66	1219.66	1201.33
	S_2	462.91	440.63	309.41	404.32	1222.66	1223.66	1213.33	1219.88
	S_3	271.03	336.78	172.28	260.03	1145.66	1191.66	786.33	1041.22
Mean		373.37	377.03	268.62	339.67	1186.33	1203.00	1073.11	1154.14
M_2	S_1	714.90	622.84	349.12	562.29	1802.33	1716.66	1423.66	1647.55
	S_2	574.54	496.99	278.01	449.85	1654.00	1469.33	1258.00	1460.44
	S_3	258.96	321.75	172.55	251.08	1299.00	1388.00	1230.00	1305.66
Mean		516.13	480.53	266.56	421.07	1585.11	1524.66	1303.88	1471.22
M_3	S_1	524.10	361.74	238.02	374.62	1239.66	1217.00	1123.66	1193.44
	S_2	244.20	429.10	195.09	289.46	1149.66	1236.00	1066.00	1150.55
	S_3	178.72	221.92	121.02	173.89	1058.33	1130.33	697.33	962.00
Mean		315.67	337.58	184.71	279.32	1149.22	1194.44	962.33	1041.22

	SEd	CD (P=0.05)	SEd	CD (P=0.05)
M	8.05	22.36	21.38	59.38
S	6.37	12.93	29.21	50.57
T	8.57	18.67	15.94	32.34
MS	12.09	28.54	39.17	92.33
MT	14.55	34.37	31.07	74.04
ST	11.04	22.40	32.36	68.14
MST	19.77	41.22	51.02	106.66

Available Nutrients (NPK) in post-harvest soil

Among the rice establishment methods, sowing by drum seeder (M_2) registered highest N, P and K in blackgram (Table.4). While, lowest N, P and K was obtained in the rice establishment method of machine transplanting (M_3).

Sowing blackgram with rice fallow pulse planter (S_1) recorded the highest N, P and K. While in broadcasting (S_3) it obtained lowest N, P and K under several method of sowing.

In the case of different time of sowing, sowing at 10 days before harvesting of rice (T_1) produced the highest N, P and K. Whereas, consistently lowest N, P and K recorded at 1 day after harvesting rice (T_3). Archana Kumari *et al.* (2012) studied that early sowing on October 10 resulted in a considerable increase in N, P and K absorption compared to sowing on October 30.

There was no interaction between the treatments on N, P and K in post-harvest soil.

Table 4. Effect of methods and time of sowing and rice establishment methods on available nutrients (NPK) (kg ha^{-1}) of rice fallow blackgram (RFB)

Treatment	N	P	K
Main - Establishment method of Rice			
M_1- Line planting by manual method	216.25	11.55	147.11
M_2- Sowing by drum seeder	221.22	11.74	159.03
M_3- Transplanting by machine	212.84	11.50	143.94
SEd	0.05	0.002	0.14
CD (P=0.05)	0.16	0.005	0.39
Sub - Method of sowing RFB			
S_1- Sowing by rice fallow pulse planter	225.03	12.04	154.34
S_2- Random dibbling by manual method	218.14	11.67	149.50
S_3- Sowing by broadcasting (Farmer's practice)	207.13	11.08	146.23
SEd	1.68	0.07	0.37
CD (P=0.05)	3.66	0.17	0.82
Sub-sub - Time of sowing of RFB			
T_1- 10 days before rice harvest	222.13	12.23	153.99
T_2-7 days before rice harvest	215.99	11.73	149.90
T_3- One day after rice harvest	212.19	10.82	146.19
SEd	1.41	0.07	1.01
CD (P=0.05)	2.87	0.15	2.04

Interaction (SEd)	4.20	0.21	2.53
Interaction CD (P=0.05)	NS	NS	NS

Conclusion

From this investigation, it could be concluded that sowing rice fallow blackgram with rice fallow pulse planter at 10 days before rice harvesting under the rice establishment method of drum seeder is the best management practice to get better growth, yield and yield attributes besides growth analysis in rice fallow blackgram.

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