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Evaluation of green gram varieties with different seed rate in rice fallow condition under sodic soil

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Abstract
Field experiments were conducted at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirapalli under *rice fallow* season 2016 and 2017 to select a suitable green gram variety and to optimize the seed rate for higher productivity of rice fallow green gram under sodic soil. The experiments were laid out in split plot design with three replications. The main plot treatments comprised of five green gram varieties (ADT 3, VBN 2, VBN (Gg) 3, Co(Gg) 7 and Co(Gg) 8) and the sub plots were three levels of seed rate (25, 30 and 35 kg/ha). The results revealed that the green gram variety Co(Gg) 8 registered higher plant population per m^2, yield attributes and grain yield. However, it was comparable with ADT 3. Green gram sown at 35 kg/ha seed rate registered significantly higher plant population per m^2, yield attributes and grain yield over 30 and 25 kg/ha. Hence, green gram variety, Co(Gg) 8 sown at 35 kg/ha recorded higher productivity, net returns and BC ratio under rice fallow condition in sodic soil.

Keywords: Rice fallow green gram, varieties, seed rate, growth, yield, economics

Introduction
Green gram (*Vigna radiata* L.) is one of the most important pulse crops in India, ranks third in production (Rathika *et al.,* 2023) [10, 11]. It is grown under irrigated, rainfed and rice fallow conditions (Ramesh and Rathika, 2016) [6, 7]. In India, green gram is grown in an area of 4.75 M ha with production of 2.45 M tonnes and average productivity of 516 kg ha-1 (Indiastat, 2019-20) [3]. In Tamil Nadu, the area, production and productivity of green gram is 1.71 lakh ha, 0.55 lakh tonnes and 321.6 kg/ha, respectively. It is extensively cultivated in Tiruvarur, Nagapattinam, Thoothukudi and Virudhunagar districts which together accounts for 60.7% of the total area under this crop in the state.

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 the state (Rathika and Ramesh, 2023) [10, 11]. The rice fallow pulses are cultivated in Tiruvarur, Thanjavur, Nagapattinam Districts and some parts of Pudukottai, Trichy and Cuddalore Districts in Cauvery Delta Zone with an average productivity of 204 kg/ha (Rathika *et al.,* 2020) [9]. 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, it has to survive in the residual nutrients and moisture present in the soil, besides frost and mist available during the period and complete the lifecycle within 65-70 days of sowing (Ramesh *et al.,* 2016) [6, 7]. ADT 3 is the most common variety for green gram in the canal dependent samba rice area of the Cauvery Delta Zone where the soil is heavy clayey in nature. A new green gram varieties needs to be tested in the Cauvery Delta Zone of Tamil Nadu. Seed rate is playing an important role for maintaining optimum plant population.

Presently, rice fallow green gram is being raised in coastal saline soil areas of Tiruvarur and Nagapattinam districts in the residual soil moisture after the samba paddy. However, sodic soils in the Trichy district are posing serious problem for cultivation of rice fallow green gram. Hence, the farmers are leaving the land as fallow after the samba paddy. In these circumstances, an investigation on the possibility of raising green gram as rice fallow crop in the sodic soil will not only increase the area and production of green gram but also effectively utilize the residual soil moisture and nutrients present in the samba paddy fields. Selection of suitable green gram variety for sodic soil and optimization of seed rate are the prime importance to promote green gram under sodic soil. Hence, the present study was undertaken.

Materials and Methods

Field experiments were conducted at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirapalli under *rice fallow* season 2016 and 2017 to select a suitable green gram variety and to optimize the seed rate for higher productivity of rice fallow green gram under sodic soil. The soil of the experimental field was sandy clay loam with pH of 8.8 and EC of 0.4 dS/m and ESP of 21.8 percent, respectively. The experimental soil was low in available nitrogen (227 kg/ha), medium in available phosphorus (14.5 kg//ha) and high in available potassium (288 kg/ha), respectively. The experiments were laid out in split plot design with three replications. The main plot treatments comprised of five green gram varieties (ADT 3, VBN 2, VBN (Gg) 3, Co(Gg) 7 and Co(Gg) 8) and the sub plots were three levels of seed rate (25, 30 and 35 kg/ha).

Observations on plant population (No./m^2), growth and yield parameters of green 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 green 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 population

Green gram varieties significantly influenced the plant population/m^2 at harvest (Table 1). Among the green gram varieties, plant population was significantly higher under Co(Gg) 8 (35 Nos./ m^2) followed by ADT 3, VBN(Gg) 3 and VBN 2. The plant population was lower under Co(Gg) 7 (24 Nos./m^2).

Use of higher seed rate (35 kg/ha) in rice fallow green gram registered higher plant population/m^2 as compared to lower seed rates (25 and 30 kg/ha). The plant population was 35, 30 and 20/m^2 under 35, 30 and 25 kg/ha seed rates, respectively. This is line with the findings of Rathika and Ramesh (2018) in rice fallow black gram.

Effect on plant height

The plant height was significantly influenced by rice fallow green gram grown with different varieties (Table 1). Among the green gram varieties, taller plants were registered with Co(Gg) 7 followed by VBN(Gg) 3, VBN 2 and ADT 3. The shortest plant was registered with Co(Gg) 8 during both the years. The significant variations in plant height among the varieties may be due to their genetic variability for this trait. The similar results have also been reported by Verma *et al.* (2011) [16] and Rathika and Ramesh (2023) [10, 11].

There was no significant influence on plant height due to different seed rates during both the years. This in agreement with the findings of Ekanayake *et al.* (2011) [1] in rainfed black gram and Rathika and Ramesh (2018) [8] in rice fallow black gram.

Effect on yield parameters

The number of pods/plant of rice fallow green gram was significantly varied due to varieties and levels of seed rate (Table 2).

Among the varieties tested, Co(Gg) 8 recorded higher number of pods/plant (11) followed by ADT 3, VBN(Gg) 3 and VBN 2. The number of pods/plant (7) was lower under rice fallow green gram sown with Co(Gg) 7 during both the years. This might be due to genetic variability of cultivars. The results are in line with the findings of Panotra *et al*. (2016) [13].

Among the levels of seed rate, green gram sown at 35 kg/ha produced more number of pods/plant over 30 kg/ha and 25 kg/ha. This finding is conformity with Tomar *et al.* (1996) [15] and Rathika and Ramesh (2018) [8].

There was no significant influence on number of seeds/pod due to different varieties and seed rate under rice fallow condition.

The 100 seed weight was significantly influenced by different varieties sown under rice fallow condition. Among the green gram varieties, Co(Gg) 7 registerd higher 100 seed weight (4.0 g) followed by VBN(Gg) 3 (3.6 g), VBN 2 (3.4 g) and Co(Gg) 8 (3.0 g). The lowest 100 seed weight was recorded with ADT 3 (2.6 g). The probable reason for this may be the genetic makeup of the variety that has helped in improving the photosynthetic activity due to increased source capacity and efficient translocation of photosynthates to the sink. Similarly Yadahalli *et al*. (2006) [17] also observed improvement in black gram varieties having different genetic makeup. However, the 100 seed weight was not varied significantly among the seed rates used. The finding on variation in yield of different varieties is in agreement with the result reported by Rathika and Ramesh (2023) [10, 11].

Effect on grain yield

The effect of varieties and seed rate showed significant influence on the grain yield of rice fallow green gram during both the years (Table 3).

Grain yield of green gram was higher under Co(Gg) 8 (343 kg/ha) and it was on par with ADT 3 (320 kg/ha). This might be due to that increased plant population/m^2 and higher production efficiency that has been reflected through improvement in different yield attributing characters. The lowest grain yield (177 kg/ha) was recorded with under rice fallow green gram sown with Co(Gg) 7. Similar results have been reported by Singh *et al*. (2003) [14] in mung bean,

Among the seed rate used in this experiment, increased seed rate (35 kg/ha) registered higher grain yield of 359 kg/ha over lower seed rate mainly due to higher plant population and yield attributes. Seed rate of 30 and 25 kg/ha recorded lesser grain yields than 35 kg/ha. Lesser plant population of 20 Nos./m^2 was recorded under seed rate of 25 kg/ha resulted in poor ground coverage, resource utilization and thus lesser grain yield. Similar results were also reported by Rathore *et al.* (2010) [12] and Rathika and Ramesh (2018) [8] in black gram.

Effect on economics

Economic analysis of varieties and seed rates in rice fallow green gram revealed that there was positive response in net returns and benefit cost ratio as compared to existing practices (Table 3).

Among the varieties, Co(Gg) 8 registered the highest net returns and BC ratio in both the years (Rs. 9230/ha and 2.17) followed by ADT 3. The better yield attributes and yields produced by Co(Gg) 8 which might be responsible for higher economics of green gram. The lowest net returns and BC ratio (Rs. 1669/ha and 1.21) were recorded with Co(Gg) 7. This was due to lowest grain yield per hectare. Similar findings were also made by Joshi and Rahevar (2015) [4].

Among the seed rate used in this experiment, higher net returns and BC ratio were obtained with rice fallow green gram sown with 35 kg/ha during both the years and the mean value of Rs.9858/ha and 2.20. This was followed by 30 kg/ha seed rate. The lowest net returns and BC ratio were recorded with 25 kg/ha seed rate.

Table 1: Effect of varieties and seed rate on the plant population and plant height of rice fallow green gram

Treatments	Plant population (No./m^2)			Plant height (cm)		
	2016	2017	Pooled	2016	2017	Pooled
Varieties						
V_1 - ADT 3	32	36	33	29.0	30.4	29.7
V_2 - VBN 2	26	29	26	30.2	31.7	31.0
V_3 - VBN (Gg) 3	30	34	30	31.4	32.9	32.2
V_4 - Co (Gg) 7	21	25	24	32.6	34.2	33.4
V_5 - Co (Gg) 8	34	37	35	28.2	29.8	29.0
SEd	1.0	1.1	1.2	0.8	0.9	1.1
CD (P=0.05)	2.1	2.2	2.4	1.6	1.8	2.2
Seed rate						
S_1 - 25 kg/ha	18	21	20	29.9	30.8	30.4
S_2 - 30 kg/ha	27	28	30	30.2	31.4	30.8
S_3 - 35 kg/ha	33	36	35	30.6	31.7	31.2
SEd	0.9	0.9	1.0	0.9	0.8	1.0
CD (P=0.05)	1.8	1.8	2.0	NS	NS	NS

Interaction absent

Table 2: Effect of varieties and seed rate on the yield attributes of rice fallow green gram

Treatments	No. of pods/plant			No. of seeds/pod			100 seed weight (g)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Varieties									
V_1 - ADT 3	9	10	10	8.2	8.3	8.3	2.4	2.8	2.6
V_2 - VBN 2	8	7	8	8.0	7.8	7.9	3.2	3.6	3.4
V_3 - VBN (Gg) 3	8	8	8	7.9	8.0	8.0	3.4	3.7	3.6
V_4 - Co (Gg) 7	7	7	7	7.7	7.9	7.8	3.9	4.1	4.0
V_5 - Co (Gg) 8	10	11	11	8.2	8.2	8.2	2.9	3.2	3.0
SEd	0.3	0.2	0.3	0.3	0.4	0.4	0.1	0.1	0.1
CD (P=0.05)	0.6	0.5	0.7	NS	NS	NS	0.2	0.3	0.2
Seed rate									
S_1 - 25 kg/ha	8	9	9	7.8	7.7	7.8	3.0	3.4	3.2
S_2 - 30 kg/ha	9	9	9	7.9	7.9	7.9	3.1	3.6	3.4
S_3 - 35 kg/ha	9	11	10	8.3	8.2	8.3	3.3	3.8	3.6
SEd	0.2	0.3	0.2	0.4	0.3	0.3	0.2	0.2	0.2
CD (P=0.05)	0.4	0.6	0.5	NS	NS	NS	NS	NS	NS

Interaction absent

Table 3: Effect of varieties and seed rate on the grain yield and economics of rice fallow green gram

Treatments	Grain yield (kg/ha)			Net return (Rs./ha)			BC ratio		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Varieties									
V_1 - ADT 3	295	343	320	5910	11230	8570	2.00	2.20	2.10
V_2 - VBN 2	188	239	213	1224	5590	3407	1.19	1.64	1.42
V_3 - VBN (Gg) 3	241	289	268	3344	8440	5892	1.53	1.95	1.74
V_4 - Co (Gg) 7	148	190	177	238	3100	1669	1.04	1.37	1.21
V_5 - Co (Gg) 8	313	358	343	6430	12030	9230	2.06	2.27	2.17
SEd	11	16	12	-	-	-	-	-	-
CD (P=0.05)	22	32	24	-	-	-	-	-	-
Seed rate									
S_1 - 25 kg/ha	177	214	195	1178	4590	2884	1.20	1.56	1.38
S_2 - 30 kg/ha	278	333	314	4768	10428	7598	1.75	2.09	1.92
S_3 - 35 kg/ha	334	376	359	6958	12758	9858	2.09	2.30	2.20
SEd	13	15	14	-	-	-	-	-	-
CD (P=0.05)	26	30	28	-	-	-	-	-	-

Interaction absent

Conclusion

From this study it was concluded that green gram variety Co(Gg) 8 sown at 35 kg/ha recorded higher productivity, net returns and BC ratio under rice fallow condition in sodic soil.

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