

## Original Research Article

### **Effect of organic manures on productivity of greengram-wheatcropping sequence under organic farming**

#### **ABSTRACT**

Manures are significant organic source of plant nutrients. Farmer's awareness is increasing towards organic farming. An experiment was conducted during *kharif* and *Rabi* season of the years 2016-17 to 2018-19 (Three years) at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar having loamy sand soil to study the effect of organic manures on productivity of greengram-wheat cropping sequence under organic farming. The experiment was laid out in completely randomized design and replicated eight times with four treatments. On three years pooled results, growing organically wheat after greengram as succeeding crop are recommended to apply 100% recommended nitrogen to greengram and 75% recommended nitrogen to succeeding wheat crop through castor cake for obtaining higher greengram equivalent yield and net return under North Gujarat Agro climatic conditions.

Keywords: Organic manures, Castor cake, FYM, Nitrogen, Greengram and Wheat

#### **I. INTRODUCTION**

Pulses are one of the important crop for India. They are important source of protein, quickly growing, generate good profit for farmers and contribute to agricultural and environmental sustainability. Pulses constitute the major source of dietary protein predominantly for vegetarians of the world. Pulses are gaining more significance globally, because of its nutritional quality and suitability to various cropping systems. Among the different pulses Green gram (*Vignaradiata* (L.) Wilczek), is an important crop ranks third in production after Chickpea and Pigeon pea (Dixit, 2005). According to Vavilov (1926), Green gram is native of India and Central Asia. Mungbean is also known as greengram, golden gram, mung or oregon pea. Green gram is a self-pollinated legume crop.

Wheat (*Triticum aestivum* L.) is grown all over the world for its high nutritious value. It is ranked among the top three most produced cereal crops in the world, along with corn and rice (Byerlee & Polanco, 1983). Wheat grain is consumed in several ways in a number of industrial and commercial products. It is also a cheaper source of feed for livestock and poultry.

Organic farming is a production system, which avoids or largely excludes the use of synthetic or inorganic fertilizers, pesticides and growth regulators (Reddy, 2005). The role of organic manure provides all nutrients that are required by plants but in limited quantities. It helps in maintaining C:N ratio in the soil and also increased the fertility and productivity of the soil. It is well recognized and considered as a balance manure which supplies macro and micro nutrients essential

to plants. It builds up the soil micro flora, which are useful to maintain the soil fertility. It supplies nitrogen, phosphorus, potassium and micronutrients like Fe, S, Mo and Zn *etc.* in available form to the plants through biological decomposition and improve physico-chemical properties of soil such as aggregation, aeration, permeability, water holding capacity, slow release of nutrients, increase in cation exchange capacity, stimulation of soil flora and fauna *etc.* Therefore, it is right time to evaluate the feasibility and efficiency of organic manure for improving and building up the soil fertility.

The application of organic manures *viz.*, FYM, vermicompost and castor cake may serve the source of major (N, P and K) and micronutrients (Fe, Mo and Zn *etc.*). Addition of organic manure in the soil is not only act as source of nutrient, but also influences its availability. It improves physical and chemical properties and health of soil such as aggregation, aeration, permeability, water holding capacity, slow release of nutrients, increase in Cation Exchange Capacity (CEC), stimulation of soil flora and fauna *etc.* FYM is one of the oldest manure used by the farmers in growing crops because of its easy availability and presence of all the nutrients required by the plants. On an average, FYM contains 0.5 % N, 0.17 % P<sub>2</sub>O<sub>5</sub> and 0.55 % K<sub>2</sub>O. Castor cake is not used as animal feed as it contains a toxic alkaloids ricinine and ricin. It widely used as concentrated organic manure. Castor cake also supply micronutrients, improve physical properties of soil, immobilize toxic elements like Al and promote Mo activity (Lima *et al.*, 2011). It is a long-term sustainable perspective and should not be thought for a short-term gain. Vermicompost is the product of decomposition process using various species of worm, usually red wigglers, white worms, and other earthworms. For preparation of mixture of decomposition of vegetable or food waste, bedding materials and vermicast. This process is called vermicomposting, while rearing of worms for this purpose is called vermiculture. Vermicompost contains 1.2 - 1.6 % N, 1.8 - 2.0% P and 0.5 - 0.75 % K. Castor cake is nitrogen rich organic fertilizer, obtained from treatment of seeds for castor oil, which act progressively and encourages soil microbial activity it has insecticidal properties and acts as a natural pest repellent. Castor cake is produced by crushing castor seeds in expeller to extract oil from it in a control temperature with help of steam. Castor oil cake is one of the most versatile natural manures which enhances the fertility of the soil without causing any damage and decay. Castor cake is also called as a castor meal. Castor cake is not used as animal feed as it contains a toxic alkaloids ricinine and ricin. It widely used as concentrated organic manure. Castor cake contains 5.5 to 5.8% N, 1.8 to 1.9% P<sub>2</sub>O<sub>5</sub> and 1.0 to 1.1% K<sub>2</sub>O. Nutrient present in castor cake are make easily and quickly available to crop after 15 to 20 days of its application.

The aim of present study was to determine the influence of organic sources of nutrients in different combination on growth and yield of green gram-wheat cropping sequence grown in organic farming systems.

## II. MATERIAL and METHODS

An experiment was conducted during *kharif* and *Rabi* season of the years 2016-17 to 2018-19 (Three years) at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar having loamy sand soil to study the effect of organic manures on productivity of greengram-wheat cropping sequence under organic farming. The experiment was laid out in completely randomized design and replicated eight times with four treatments in *kharif* season for green gram *viz.*, T<sub>1</sub>: 100% RDN through FYM, T<sub>2</sub>: 100% RDN through FYM, T<sub>3</sub>: 100% RDN through castor cake and T<sub>4</sub>: 100%

RDN through castor cake and in *rabi* season for wheat as a sequence crop viz., T<sub>1</sub>: 75% RDN through vermicompost, T<sub>2</sub>: 50% RDN through vermicompost, T<sub>3</sub>: 75% RDN through castor cake, and T<sub>4</sub>: 50% RDN through castor cake. Green gram variety GM-4 while Wheat variety GW-451 was used as test crop. The soil of experimental field was loamy sand in texture. In *kharif* season green gram seeds (17.5 kg/ha) were sown at a row distance of 45 cm and in *rabi* season wheat seeds (125 kg/ha) were sown at a row distance of 22.5 cm. Various growth and yield attributing characters of the crop were measured and studied during the course of investigations. Other management practices were followed as recommended. Statistical analysis of the data of various characters studied in present investigation was carried out with the help of computer as per appropriate procedure suggested by Panse and Sukhatme (1985) for the design of experiment.

### III. RESULTS and DISCUSSION

#### **2017-18**

The data presented in Table 6 indicated that application of different organic manures had significant effect on green gram equivalent yield. Significantly the highest green gram equivalent yield (2136 kg/ha) was registered under treatment T<sub>3</sub> (100% RDN through castor cake in green gram and 75% RDN through castor cake in succeeding wheat) over rest of the treatments. However, treatment T<sub>4</sub> (100% RDN through castor cake in green gram and 50% castor cake in succeeding wheat) recorded significantly lower green gram equivalent yield (1779 kg/ha) and remained at par with treatment T<sub>2</sub> (100% RDN through FYM in green gram and 50% RDN through vermicompost in succeeding wheat).

#### **2018-19**

The data tabulated in Table 6 revealed that application of different organic manures to green gram-wheat crop sequence had significant effect on green gram equivalent yield. Significantly the highest green gram equivalent yield (2629 kg/ha) was registered under treatment T<sub>3</sub> (100% RDN through castor cake in green gram and 75% RDN through castor cake in succeeding wheat). However, treatment T<sub>4</sub> (100% RDN through castor cake in green gram and 50% castor cake in succeeding wheat) recorded significantly lower green gram equivalent yield (2247 kg/ha) and did not differ significantly over treatment T<sub>2</sub> (100% RDN through FYM in green gram and 50% RDN through vermicompost in succeeding wheat).

#### **2019-20**

The data highlighted in Table 6 revealed that application of different organic manures to green gram-wheat crop sequence had significant effect on green gram equivalent yield. Significantly the highest green gram equivalent yield (2969 kg/ha) was registered under treatment T<sub>3</sub> (100% RDN through castor cake in green gram and 75% RDN through castor cake in succeeding wheat). However, treatment T<sub>4</sub> (100% RDN through castor cake in green gram and 50% castor cake in succeeding wheat) recorded significantly lower green gram equivalent yield (2446 kg/ha) but failed to differ significantly over treatment T<sub>2</sub> (100% RDN through FYM in green gram and 50% RDN through vermicompost in succeeding wheat).

#### **Pooled results**

The pooled data of three years (Table 6) indicated that application of different organic manures to green gram-wheat crop sequence had significant effect on green gram equivalent yield. Significantly the highest green gram equivalent yield (2578 kg/ha) was registered under treatment T<sub>3</sub> (100% RDN through castor cake in green gram and 75% RDN through castor cake in succeeding wheat). However, treatment T<sub>4</sub> (100% RDN through castor cake in green gram and 50% castor cake in

succeeding wheat) recorded significantly lower greengram equivalent yield (2157 kg/ha) and remained at par with treatment T<sub>2</sub> (100% RDN through FYM in greengram and 50% RDN through vermicompost in succeeding wheat). The results indicated that the residual effect of organic manures applied to preceding *kharif* greengram resulted in saving of 25% RDN for succeeding *rabi* wheat.

Castor cake's contribution to higher yields in the wheat-greengram cropping sequence has been documented in several studies. For instance, research by Patel et al. (2019) demonstrated that the application of castor cake significantly increased wheat yields in a wheat-greengram rotation system. This increase was attributed to the nutrient-rich composition and slow-release properties of castor cake, as well as its positive impact on soil health and fertility (Patel *et al.*, 2019). Furthermore, findings from Sharma *et al.* (2020) support these results, highlighting the beneficial effects of castor cake application on both wheat and greengram yields in a crop rotation system. These studies emphasize the importance of castor cake as an effective organic fertilizer for improving yields and promoting sustainable agricultural practices in wheat-greengram cropping sequences. Also similar result was reported by Mahajan *et al.* (2017), Dubey *et al.* (2018), Nisha *et al.* (2018) and Panwar *et al.* (2019).

### **Economics**

Economics of different treatments (Table 15) showed that maximum gross return (Rs 180460/ha) and net return (Rs 107646/ha) with BCR of 2.48 was obtained with treatment T<sub>3</sub> (100% RDN through castor cake in greengram and 75% RDN through castor cake in succeeding wheat). Which was followed by treatment T<sub>4</sub> (100% RDN through castor cake in greengram and 50% castor cake in succeeding wheat) with net return (Rs. 82438) and BCR of 2.20.

### **Microbial studies:**

The soil population of *Rhizobium*, *Azotobacter* and PSB in greengram-wheat cropping sequence were influenced by the treatments (Table 16). The population of microorganisms were evaluated using serial dilution and standard plating. The population of soil bacteria showed significant variation among the treatments under investigation.

The treatment T<sub>3</sub> [100% RDN through castor cake in greengram; 75% RDN through castor cake in wheat] showed highest number of *Rhizobium*, *Azotobacter*, and PSB which was followed by the treatment T<sub>4</sub> [100% RDN through castor cake in greengram; 50% RDN through castor cake in wheat].

### **Chemical studies:**

#### **1. Nutrient content in seed and stover of greengram**

The perusal of data presented in Table 17 showed that treatment T<sub>1</sub> registered maximum N content in greengram seed on pooled basis. Whereas, significantly higher P and K content in seed was observed under treatment T<sub>3</sub> but, it was at par with treatment T<sub>1</sub> on pooled basis. The data given in Table 18 indicated that treatment T<sub>1</sub> recorded significantly higher N and P content in greengram stover but, it was at par with treatment T<sub>3</sub> on pooled basis. While, treatment T<sub>3</sub> registered significantly higher K content in stover, which remained at par with treatment T<sub>1</sub> on pooled basis.

#### **2. N, P and K uptake by greengram seed**

The data presented in Table 19 revealed that maximum N uptake by green gram seed was observed under treatment T<sub>3</sub>. While, significantly higher P uptake by green gram seed was registered by treatment T<sub>3</sub>, but it was at par with treatment T<sub>1</sub>, whereas treatment T<sub>3</sub> resulted in significantly the highest K uptake by greengram seed over rest of the treatments on pooled basis.

#### **3. N, P and K uptake by greengram stover**

The data presented in Table 20 showed that significantly higher N and P uptake by greengram

stover was observed with the application of 100% RDN through CC (T<sub>3</sub>) but did not differ with treatment T<sub>1</sub> in case of N and P uptake by green gram stover on pooled basis. However, treatment T<sub>3</sub> recorded significantly the highest K uptake by greengram stover.

#### **4. Nutrient content in wheat grain and straw:**

The data presented in Table 21 revealed that maximum content of N in wheat grain was recorded by T<sub>1</sub> treatment, whereas maximum content of P was registered by T<sub>3</sub> treatment on pooled basis. While treatment T<sub>1</sub> resulted in significantly higher K content (0.629%) in grain, but it was at par with treatment T<sub>3</sub> on pooled basis. Treatment T<sub>1</sub> registered significantly higher N and P content in wheat straw but, it was at par with treatment T<sub>3</sub> on pooled basis. Whereas, treatment T<sub>3</sub> was resulted in insignificantly higher K content in wheat straw, but it was at par with treatment T<sub>1</sub> (Table 22).

#### **5. N, P and K uptake by wheat grain**

A perusal of data (Table 23) indicated that maximum N and P uptake by wheat grain was observed under treatment T<sub>3</sub> on pooled basis. Treatment T<sub>3</sub> resulted insignificantly higher K uptake by wheat grain over rest of the treatments on pooled basis. On the contrary, significantly the highest N, P and K uptake by wheat straw was noted under treatment T<sub>3</sub> on pooled basis (Table 24).

#### **6. EC and pH of soil after completion of cycle**

The data presented in Table 25 to 28 on EC, pH, organic carbon, available N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and S content in soil after completion of crop cycle did not differ due to various treatments in pooled results.

#### **Conclusion**

Based on findings of three years experimentation, it is concluded that application of 100% recommended nitrogen to greengram and 75% recommended nitrogen to succeeding wheat crop through castor cake for obtaining higher greengram equivalent yield and net return.

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CV(%)	7.86	6.73	6.86	12.65	7.52	6.73	8.32	12.65
YxT	-	-	-	NS	-	-	-	NS

**Table 2: Plant height and number of branches per plant of greengram as influenced by different treatments**

Treatments	Plantheight(cm)				Numberofbranchesperplant			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled
Greengram								
T <sub>1</sub> :100%RDN throughFYM	45.1	50.8	52.7	49.5	4.4	5.9	6.3	5.6
T <sub>2</sub> :100%RDN throughFYM	44.0	49.7	51.8	48.5	4.8	5.7	6.1	5.6
T <sub>3</sub> :100%RDN throughCC	47.1	52.1	53.9	51.0	4.4	6.4	7.0	5.9
T <sub>4</sub> :100%RDN throughCC	46.2	50.9	54.4	50.5	4.4	6.3	6.7	5.8
S.Em.±	1.5	1.5	1.8	1.0	0.2	0.2	0.2	0.2
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	10.01	8.33	9.32	8.71	11.96	9.74	9.79	10.28
YxT	-	-	-	NS	-	-	-	NS

**Table 3: Number of pods per plant and length of pod of greengram as influenced by different treatments**

Treatments	Numberofpodspersplant				Lengthofpod(cm)			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled
Greengram								
T <sub>1</sub> :100%RDN throughFYM	15.7	18.3	20.2	18.1	4.6	5.1	5.3	5.2
T <sub>2</sub> :100%RDN throughFYM	15.6	18.0	20.1	17.9	4.4	5.3	6.1	5.3
T <sub>3</sub> :100%RDN throughCC	17.1	20.0	22.2	19.8	4.8	5.2	5.9	5.3
T <sub>4</sub> :100%RDN throughCC	16.2	18.5	21.5	18.7	4.6	5.5	6.3	5.4
S.Em.±	0.6	0.5	0.63	0.3	0.2	0.2	0.2	0.1
CD(P=0.05)	NS	NS	NS	0.9	NS	NS	NS	NS
CV(%)	9.86	8.09	8.51	8.72	13.81	10.65	9.35	11.14
YxT	-	-	-	NS	-	-	-	NS

**Table 4: Seeds per pod and Seed yield per plant of greengram as influenced by different treatments**

Treatments	Seedperpod				Seedyieldperplant(g)			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled
Greengram								
T <sub>1</sub> :100%RDN throughFY M	8.7	9.5	9.5	9.2	7.1	8.2	8.4	7.9
T <sub>2</sub> :100%RDN through FYM	8.4	9.3	9.4	9.1	7.0	8.1	8.3	7.8
T <sub>3</sub> :100%RDN throughCC	9.9	10.9	10.7	10.5	7.3	8.5	8.6	8.2
T <sub>4</sub> :100%RDN throughCC	8.7	9.4	9.3	9.1	7.1	8.4	8.7	8.0
S.Em.±	0.2	0.1	0.2	0.1	0.1	0.1	0.2	0.1
CD(P=0.05)	0.4	0.4	0.5	0.2	NS	NS	NS	0.2
CV(%)	4.70	4.11	4.90	4.63	3.62	4.11	5.46	4.50
YxT	-	-	-	NS				NS

**Table5: Testweightofgreengramasinfluencedbydifferenttreatments**

Treatments	Testweight(g)			
	2017	2018	2019	Pooled
Greengram				
T <sub>1</sub> :100%RDNthroughFYM	36.53	37.09	37.43	37.02
T <sub>2</sub> :100%RDNthroughFYM	35.68	36.39	37.35	36.47
T <sub>3</sub> :100%RDNthroughCC	36.86	37.54	37.38	37.39
T <sub>4</sub> :100%RDNthroughCC	36.02	36.48	37.51	36.67
S.Em.±	0.31	0.32	0.54	0.23
CD(P=0.05)	NS	NS	NS	0.64
CV(%)	2.43	2.45	4.06	3.10
YxT	-	-	-	NS

**Table6: Seedandstoveryieldofgreengramasinfluencedbydifferenttreatments**

Treatments	Seedyield(kg/ha)				Stoveryield(kg/ha)			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled
Greengram								
T <sub>1</sub> :100%RDN throughFY M	415	490	536	480	862	948	1078	963
T <sub>2</sub> :100%RDN through FYM	410	495	523	475	812	1009	1075	965
T <sub>3</sub> :100%RDN throughCC	420	514	552	495	906	1036	1025	989
T <sub>4</sub> :100%RDN throughCC	413	507	541	487	844	1097	1121	1021
S.Em.±	12	12	19	9	30	26	30	28
CD(P=0.05)	NS	NS	NS	NS	NS	75.82	NS	NS
CV(%)	7.94	6.66	10.08	8.60	10.01	7.13	7.95	28.09
YxT	-	-	-	NS	-	-	-	NS

**Table7:Plantpopulationofwheatasinfluencedbydifferenttreatments**

Treatments	Plant population at 20 DAS				Plant population at harvest			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled
Wheat	26.0	26.3	26.8	26.3	24.4	24.6	24.6	24.6
T <sub>1</sub> :75%RDN throughVC	26.0	26.3	26.8	26.3	24.4	24.6	24.6	24.6
T <sub>2</sub> :50%RDN throughVC	26.0	25.4	26.3	25.9	24.6	23.6	24.1	24.1
T <sub>3</sub> :75%RDN throughCC	26.3	26.6	27.0	26.6	24.8	25.6	25.5	25.3
T <sub>4</sub> :50%RDN throughCC	26.1	26.4	26.9	26.5	25.3	25.6	25.9	25.6
S.Em.±	0.9	0.9	1.0	0.5	0.8	0.8	0.9	0.4
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	9.21	9.53	10.24	9.70	8.77	8.72	9.61	9.13
YxT	-	-	-	NS	-	-	-	NS

**Table 8: Plant height and number of effective tillers/plant of wheat as influenced by different treatments**

Treatments	Plantheight(cm)				Numberofeffectivetillers/plant			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled
Wheat	68.1	71.0	72.8	70.6	4.1	4.3	4.8	4.4
T <sub>1</sub> :75%RDN throughVC	68.1	71.0	72.8	70.6	4.1	4.3	4.8	4.4
T <sub>2</sub> :50%RDN throughVC	62.7	65.3	69.3	65.8	3.8	4.0	4.2	4.0
T <sub>3</sub> :75%RDN throughCC	74.8	77.5	80.2	77.5	4.7	5.0	5.569	5.1
T <sub>4</sub> :50%RDN throughCC	66.3	68.3	71.8	68.8	4.0	4.2	4.3	4.1
S.Em.±	2.2	2.1	2.4	1.2	0.2	0.2	0.2	0.1
CD(P=0.05)	6.5	6.0	6.9	3.4	0.5	0.6	0.6	0.3
CV(%)	9.14	8.21	9.12	8.81	11.30	12.11	12.03	11.84
YxT	-	-	-	NS	-	-	-	NS

**Table9: Lengthofspike andnumberofspikelet/spikeofwheat at harvestasinfluenced by different treatments**

Treatments	Lengthofspike(cm)				Numberofspikelet/spike			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled
Wheat	6.7	7.0	7.3	7.0	11.7	12.8	13.6	12.7
T <sub>1</sub> :75%RDN throughVC	6.7	7.0	7.3	7.0	11.7	12.8	13.6	12.7
T <sub>2</sub> :50%RDN throughVC	6.0	6.6	6.6	6.4	10.7	11.8	12.9	11.8
T <sub>3</sub> :75%RDN throughCC	7.4	7.8	8.2	7.8	13.0	14.2	15.3	14.2
T <sub>4</sub> :50%RDN throughCC	6.2	6.4	7.0	6.5	11.1	12.4	13.4	12.3
S.Em.±	0.2	0.2	0.2	0.1	0.4	0.4	0.4	0.2
CD(P=0.05)	0.6	0.7	0.7	0.4	1.2	1.2	1.3	0.7
CV(%)	8.32	9.56	9.55	9.24	10.02	8.81	9.14	9.35
YxT	-	-	-	NS	-	-	-	NS

**Table 10: Number of grain per earhead and test weight of wheat of wheat at harvest as influenced by different treatments**

Treatments	Numberofgrainperearhead				Testweight(g)			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled
Wheat								
T <sub>1</sub> :75% RDN through VC	36.38	37.20	39.10	37.56	40.13	40.38	41.06	40.52
T <sub>2</sub> :50% RDN through VC	30.24	31.98	33.46	31.89	39.94	39.38	39.38	39.56
T <sub>3</sub> :75% RDN through CC	39.95	41.69	43.19	41.61	40.25	40.63	41.93	40.94
T <sub>4</sub> :50% RDN through CC	34.86	35.88	37.70	36.14	40.00	40.25	41.34	40.53
S.Em.±	1.14	1.38	1.35	0.71	0.87	0.88	0.93	0.50
CD(P=0.05)	3.35	4.06	3.96	20.20	NS	NS	NS	NS
CV(%)	9.12	10.63	9.93	9.94	6.17	6.16	6.40	6.25
YxT	-	-	-	NS	-	-	-	NS

**Table 11: Grain yield of wheat as influenced by different treatments**

Treatments	Grain yield(kg/ha)				Straw yield((kg/ha)			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled
Wheat								
T <sub>1</sub> :75% RDN through VC	3213	4396	3913	3841	5266	5472	5337	5358
T <sub>2</sub> :50% RDN through VC	2899	4116	3660	3559	4654	4813	4740	4736
T <sub>3</sub> :75% RDN through CC	3550	4795	4389	4245	5688	5975	5874	5845
T <sub>4</sub> :50% RDN through CC	2723	3910	3397	3344	4874	4990	4832	4898
S.Em.±	122	110	123	65	152	158	171	89
CD(P=0.05)	358	322	361	185	447	465	503	251
CV(%)	11.11	7.20	9.03	8.91	8.40	8.41	9.31	8.72
YxT	-	-	-	NS	-	-	-	NS

**Table 12: Greengram equivalent yield as influenced by different treatments**

Treatments		Greengramequivalentyield(kg/ha)			
Greengram	Wheat	2017	2018	2019	Pooled
T <sub>1</sub> :100% RDN through FYM	T <sub>1</sub> :75% RDN through VC	1965	2430	2703	2366
T <sub>2</sub> :100% RDN through FYM	T <sub>2</sub> :50% RDN through VC	1824	2304	2535	2221
T <sub>3</sub> :100% RDN through CC	T <sub>3</sub> :75% RDN through CC	2136	2629	2969	2578
T <sub>4</sub> :100% RDN through CC	T <sub>4</sub> :50% RDN through CC	1779	2247	2446	2157
S.Em.±		49	43	61	29
CD(P=0.05)		144	127	179	82
CV(%)		7.17	5.08	6.45	6.24
YxT		-	-	-	NS

**Table13:Economicsofkharifgreengramasinfluencedbydifferenttreatments****(Pooleddataof2017-18,2018-19and2019-20)**

Treatments Greengram	Yield (kg/ha)		Gross return (Rs/ha)	Costof cultivation (Rs/ha)	Net return (Rs/ha)	BCR
	Seed	Stover				
T <sub>1</sub> :100%RDNthroughFYM	480	963	35526	28400	7126	1.25
T <sub>2</sub> :100%RDNthroughFYM	475	965	35180	28400	6780	1.24
T <sub>3</sub> :100%RDNthroughCC	495	989	36628	24544	12084	1.49
T <sub>4</sub> :100%RDNthroughCC	487	1021	36132	24544	11588	1.47

**Rateofdifferinput:**

- (i) FYM :Rs1.50/kg iii)Castorcake:Rs6.0/kg(Rs300/50kgbagofcastorcake)  
(ii) Rateofsellofproduceofgreengram:iv Seed:Rs70.00/kgseedStover:Rs.2.00/kgstalk

**Table 14: Economics of rabi wheat as influenced by different treatments (Pooled data of 2017-18, 2018-19 and 2019-20)**

Treatments Wheat	Yield(kg/ha)		Gross return (Rs/ha)	Costof cultivation (Rs/ha)	Net return (Rs/ha)	BCR
	Grain	Straw				
T <sub>1</sub> :75%RDNthroughVC	3841	5358	85212	60790	24422	1.40
T <sub>2</sub> :50%RDNthroughVC	3559	4736	78270	52530	25740	1.49
T <sub>3</sub> :75%RDNthroughCC	4245	5845	93945	48270	45675	1.95
T <sub>4</sub> :50%RDNthroughCC	3344	4898	74886	44008	30878	1.70

**Rateofsellofproduceofwheat:**

- (i) Seed:Rs18.00/kgseed iii)Straw:Rs.3.00/kgstalk  
(ii) VC:Rs4.00/kg iv)Castorcake:Rs6.0/kg(Rs300/50kgbagofcastorcake)

**Table15: Economics of greengram-wheat crop sequence as influenced by different treatments (Pooled data of 2017-18, 2018-19 and 2019-20)**

Treatments		Greengram equivalent yield (kg/ha)	Gross return (Rs/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	BCR
Greengram	Wheat					
T <sub>1</sub> :100%RDN throughFYM	T <sub>1</sub> :75%RDN throughVC	2366	165620	89190	76430	1.86
T <sub>2</sub> :100%RDN throughFYM	T <sub>2</sub> :50%RDN throughVC	2221	155470	80930	74540	1.92
T <sub>3</sub> :100%RDN throughCC	T <sub>3</sub> :75%RDN throughCC	2578	180460	72814	107646	2.48
T <sub>4</sub> :100%RDN throughCC	T <sub>4</sub> :50%RDN throughCC	2157	150990	68552	82438	2.20

**Rateofdifferinput:**

- (i) FYM:Rs1.50/kg ii)Castorcake:Rs6.0/kg(Rs300/50kgbagofcastorcake)  
(ii) Rateofsellofproduceofgreengram:Seed:Rs70.00/kgseed  
(iii) Stover:Rs.2.00/kgstalk

**Rateofsellofproduceofwheat:Seed:Rs18.00/kgseedStraw:Rs.3.00/kgstalk**

- (iv) VC:Rs4.00/kg  
(v) Castorcake:Rs6.0/kg(Rs300/50kgbagofcastorcake)

Table16: Soil population of *Rhizobium*, *Azotobacter* and PSB in green gram-wheat based cropping sequence

Treatments	Population of microorganisms in soil ( $\times 10^5$ CFU/g of soil)																							
	Green gram												Wheat											
	<i>Rhizobium</i>				<i>Azotobacter</i>				PSB				<i>Rhizobium</i>				<i>Azotobacter</i>				PSB			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
Before sowing	5.7	5.9	6.6	6.1	6.4	7.0	7.4	6.9	7.5	7.9	8.8	8.1	8.6	9.1	9.6	9.1	10.5	10.8	11.7	11.0	12.8	12.1	13.2	12.7
After harvest																								
T <sub>1</sub>	10.6	10.4	12.2	11.1	12.4	12.0	14.6	13.0	14.7	14.5	16.4	15.20	11.7	12.0	15.5	13.07	15.1	15.2	16.7	15.7	18.1	19.0	20.4	19.2
T <sub>2</sub>	10.7	10.3	11.2	10.7	12.2	13.0	13.3	12.8	14.4	15.0	15.3	14.90	12.5	12.6	13.1	12.73	14.8	15.0	15.6	15.1	17.5	17.9	18.8	18.1
T <sub>3</sub>	12.6	12.9	13.4	13.0	14.6	15.0	15.8	15.1	16.8	17.1	18.5	17.47	14.2	15.3	17.8	15.77	16.4	16.7	18.2	17.1	20.4	21.0	23.4	21.6
T <sub>4</sub>	12.4	12.1	12.8	12.4	14.5	14.3	14.9	14.6	16.4	16.8	17.2	16.80	13.4	14.1	15.3	14.27	15.7	16.0	17.2	16.3	19.4	18.8	21.5	19.9
S.Em $\pm$	0.36	0.45	0.51	0.20	0.47	0.62	0.49	0.33	0.53	0.41	0.57	0.23	0.62	0.44	0.55	0.49	0.67	0.52	0.71	0.1	0.43	0.49	0.66	0.30
CD(P=0.05)	1.05	1.31	1.47	0.69	1.37	1.78	1.42	1.13	1.56	1.22	1.68	0.80	1.76	1.28	1.65	1.69	1.95	1.18	2.06	0.5	1.26	1.52	1.87	1.04
CV(%)	2.63	3.67	3.18	2.94	2.86	3.84	4.55	4.08	3.34	3.68	4.35	2.49	4.61	4.75	4.62	6.05	5.21	4.97	4.72	1.6	3.66	4.81	4.32	2.64

\*Population of microorganisms in soil are expressed in terms of CFU (CFU=Colony Forming Units)/gm of soil

Table17: N, P and K content in green gram seed as influenced by different treatments

Treatments	N content (%)				P content (%)				K content (%)			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T <sub>1</sub> : 100% RDN through FYM	3.31	6.86	3.20	4.50	0.23	0.22	0.22	0.22	1.40	1.19	1.29	1.29
T <sub>2</sub> : 100% RDN through FYM	3.24	3.34	3.34	3.27	0.20	0.18	0.19	0.19	1.69	0.92	1.02	1.01
T <sub>3</sub> : 100% RDN through CC	3.34	3.24	3.24	3.30	0.23	0.23	0.23	0.23	1.45	1.20	1.32	1.32
T <sub>4</sub> : 100% RDN through CC	3.23	3.32	3.31	3.26	0.20	0.18	0.16	0.19	1.19	0.98	1.10	1.10
S.Em. $\pm$	0.030	0.030	0.030	1.045	0.010	0.010	0.003	0.003	0.030	0.030	0.030	0.019
CD(P=0.05)	NS	NS	NS	NS	0.010	0.020	0.010	0.010	0.100	0.100	0.100	0.050
CV(%)	2.65	2.65	2.62	2.60	6.72	7.82	6.92	7.15	7.52	9.00	8.26	8.22
Y x T				NS				NS				NS

**Table18: N,PandKcontentinstoverofgreengramasinfluencedbydifferenttreatments**

Treatments	Ncontent(%)				Pcontent(%)				Kcontent(%)			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T <sub>1</sub> :100%RDN throughFYM	0.91	0.82	0.83	0.85	0.15	0.16	0.16	0.16	2.68	2.53	2.55	2.58
T <sub>2</sub> :100%RDN throughFYM	0.83	0.74	0.73	0.77	0.11	0.11	0.11	0.11	2.45	2.30	2.35	2.37
T <sub>3</sub> :100%RDN throughCC	0.91	0.82	0.82	0.85	0.15	0.16	0.16	0.16	2.68	2.60	2.60	2.62
T <sub>4</sub> :100%RDN throughCC	0.80	0.74	0.72	0.75	0.11	0.11	0.12	0.11	2.40	2.29	2.33	2.34
S.Em.±	0.030	0.020	0.030	0.014	0.003	0.003	0.003	0.020	0.020	0.030	0.020	0.012
CD(P=0.05)	0.080	0.070	0.080	0.040	0.010	0.010	0.010	0.010	0.060	0.080	0.060	0.030
CV(%)	9.16	8.76	9.47	9.14	8.55	9.05	9.40	9.01	2.11	3.04	2.23	2.48
YxT				NS				NS				NS

**Table19: N,PandKuptakebygreengramseedasinfluencedbydifferenttreatments**

Treatments	Nuptake(kg/ha)				Puptake(kg/ha)				Kuuptake(kg/ha)			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T <sub>1</sub> :100%RDN throughFYM	10.41	12.60	14.42	12.51	7.86	8.35	8.89	8.37	10.44	12.56	12.52	11.84
T <sub>2</sub> :100%RDN throughFYM	10.01	13.17	13.78	12.31	6.75	7.69	7.77	7.43	9.72	12.13	12.72	11.52
T <sub>3</sub> :100%RDN throughCC	10.69	13.39	15.00	13.01	8.18	8.85	9.20	8.71	10.69	13.36	14.28	12.78
T <sub>4</sub> :100%RDN throughCC	10.11	13.48	15.04	12.85	6.74	7.97	8.00	7.51	9.71	12.26	12.99	11.64
S.Em.±	0.40	0.38	0.66	0.56	0.41	0.40	0.50	0.24	0.38	0.38	0.63	0.270
CD(P=0.05)	NS	NS	NS	NS	1.20	NS	NS	0.69	NS	NS	NS	0.76
CV(%)	10.9	8.08	12.77	12.12	15.66	13.76	16.68	15.45	10.63	8.53	13.63	11.35
YxT	-	-	-	NS	-	-	-	NS	-	-	-	NS

**Table20:N,PandKuptakebygreengramstoverasinfluencedbydifferenttreatments**

Treatments	Nuptake(kg/ha)				Puptake(kg/ha)				Kuptake(kg/ha)			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T <sub>1</sub> :100%RDN throughFYM	7.86	8.35	8.89	8.37	1.32	1.62	1.67	1.56	23.65	25.74	27.44	25.71
T <sub>2</sub> :100%RDN throughFYM	6.75	7.69	7.77	7.40	0.91	1.14	1.18	1.07	19.91	23.72	24.62	22.74
T <sub>3</sub> :100%RDN throughCC	8.18	8.85	9.20	8.74	1.38	1.66	1.75	1.60	24.21	28.48	29.03	27.24
T <sub>4</sub> :100%RDN throughCC	6.74	7.97	8.00	7.55	0.92	1.19	1.25	1.12	20.11	24.83	25.65	23.53
S.Em.±	0.41	0.41	0.50	0.24	0.05	0.80	0.05	0.03	0.76	0.86	1.11	0.51
CD(P=0.05)	1.2	NS	NS	0.69	0.14	0.23	0.16	0.10	2.22	2.52	3.26	1.45
CV(%)	15.66	13.76	16.68	15.45	11.68	16.09	10.62	13.17	9.80	9.44	11.74	10.51
YxT	-	-	-	NS	-	-	-	NS	-	-	-	NS

**Table21:N,PandKcontentinwheatgrainasinfluencedbydifferenttreatments**

Treatments	Ncontent(%)				Pcontent(%)				Kcontent(%)			
	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T <sub>1</sub> :75%RDN throughVC	2.19	2.10	2.219	2.17	0.30	0.29	0.31	0.29	0.67	0.65	0.62	0.63
T <sub>2</sub> :50%RDN throughVC	2.10	2.22	2.102	2.14	0.28	0.31	0.29	0.30	0.55	0.59	0.55	0.56
T <sub>3</sub> :75%RDN throughCC	2.22	2.11	2.188	2.17	0.31	0.29	0.28	0.31	0.62	0.64	0.61	0.63
T <sub>4</sub> :50%RDN throughCC	2.12	2.20	2.100	2.14	0.28	0.30	0.32	0.30	0.58	0.59	0.55	0.57
S.Em.±	0.03	0.03	0.04	0.04	0.01	0.01	0.01	0.10	0.02	0.02	0.02	0.01
CD(P=0.05)	NS	0.10	NS	NS	NS	NS	NS	NS	0.05	NS	0.06	0.03
CV(%)	4.49	4.45	4.85	4.60	7.92	9.00	7.92	8.41	8.77	9.16	9.81	9.25
YxT	-	-	-	NS	-	-	-	NS	-	-	-	NS

**Table22:N,PandKcontentinwheatstrawasinfluencedbydifferenttreatments**

Treatments	Ncontent(%)				Pcontent(%)				Kcontent(%)				
	Wheat	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T <sub>1</sub> :75%RDN throughVC		0.93	0.82	0.82	0.86	0.15	0.14	0.14	0.14	1.04	0.98	0.96	1.00
T <sub>2</sub> :50%RDN throughVC		0.84	0.75	0.74	0.78	0.12	0.10	0.11	0.11	0.93	0.85	0.84	0.87
T <sub>3</sub> :75%RDN throughCC		0.95	0.82	0.78	0.84	0.15	0.14	0.14	0.14	1.06	0.99	0.96	1.00
T <sub>4</sub> :50%RDN throughCC		0.84	0.75	0.76	0.78	0.11	0.101	0.11	0.11	0.93	0.82	0.81	0.85
S.Em.±		0.03	0.022	0.021	0.011	0.003	0.003	0.003	0.002	0.031	0.030	0.031	0.017
CD(P=0.05)		NS	0.06	NS	0.04	0.01	0.01	0.01	0.01	0.10	0.09	0.09	0.05
CV(%)		9.30	7.53	8.44	8.54	9.55	8.91	9.59	9.37	9.20	9.42	9.90	9.53
YxT		-	-	-	NS	-	-	-	NS	-	-	-	NS

**Table23:N,PandKuptakebywheatgrainasinfluencedbydifferenttreatments**

Treatments	Nuptake(kg/ha)				Puuptake(kg/ha)				Kuuptake(kg/ha)				
	Wheat	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T <sub>1</sub> :75%RDNthroughVC		70.50	92.40	86.89	83.26	9.72	12.52	11.07	11.10	33.49	28.52	24.20	28.73
T <sub>2</sub> :50%RDNthroughVC		60.90	91.22	77.04	76.38	8.22	12.66	11.26	10.71	27.19	24.35	20.25	23.93
T <sub>3</sub> :75%RDNthroughCC		78.75	101.01	96.21	91.99	10.92	13.60	12.53	12.35	37.38	29.58	28.22	31.73
T <sub>4</sub> :50%RDNthroughCC		56.06	85.45	71.38	70.96	7.74	11.89	10.21	9.95	24.76	22.21	18.17	21.71
S.Em.±		2.780	2.560	3.300	2.896	0.470	0.490	0.500	0.486	1.810	1.080	1.420	0.839
CD(P=0.05)		8.180	7.540	9.690	NS	1.380	NS	1.480	NS	5.340	3.180	4.180	2.370
CV(%)		11.82	7.84	11.25	10.16	14.46	10.85	12.65	12.47	16.71	11.67	17.69	15.67
YxT		-	-	-	NS	-	-	-	NS	-	-	-	NS

**Table24: N,PandKuptakebywheatstrawasinfluencedbydifferenttreatments**

Treatments	Nuptake(kg/ha)				Puptake(kg/ha)				Kuptake(kg/ha)				
	Wheat	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T <sub>1</sub> :75%RDN throughVC		35.94	44.78	43.35	41.36	5.62	7.78	7.37	6.92	41.42	53.62	52.58	49.51
T <sub>2</sub> :50%RDN throughVC		30.85	35.79	34.99	33.88	4.50	4.98	5.04	4.84	53.43	40.55	39.53	38.51
T <sub>3</sub> :75%RDN throughCC		39.80	48.87	45.88	44.85	6.21	8.44	8.14	7.60	45.24	58.90	57.12	53.76
T <sub>4</sub> :50%RDN throughCC		28.62	37.33	36.48	34.14	3.81	5.12	5.27	4.75	31.56	41.13	40.08	37.59
S.Em.±		1.46	1.43	1.75	0.88	0.35	0.35	0.32	0.20	2.28	1.90	2.01	1.20
CD(P=0.05)		4.29	4.21	5.16	2.48	1.03	1.02	0.93	0.61	6.69	5.55	5.92	3.37
CV(%)		12.19	9.71	12.34	12.40	19.73	14.90	13.82	15.88	16.76	11.07	12.02	13.07
YxT		-	-	-	NS	-	-	-	NS	-	-	-	NS

**Table25:ECandHofsoilaftercompletionofcycleasinfluencedbydifferenttreatments**

Treatments		EC(dSm <sup>-1</sup> )				pH			
Greengram	Wheat	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T <sub>1</sub> :100%RDNthroughFYM	T <sub>1</sub> :75%RDNthroughVC	0.12	0.11	0.11	0.12	7.70	7.74	7.67	7.70
T <sub>2</sub> :100%RDNthroughFYM	T <sub>2</sub> :50%RDNthroughVC	0.13	0.12	0.13	0.13	7.80	7.63	7.84	7.75
T <sub>3</sub> :100%RDNthroughCC	T <sub>3</sub> :75%RDNthroughCC	0.12	0.11	0.11	0.12	7.63	7.80	7.63	7.68
T <sub>4</sub> :100%RDNthroughCC	T <sub>4</sub> :50%RDNthroughCC	0.13	0.12	0.12	0.12	7.74	7.70	7.79	7.74
S.Em.±		0.003	0.002	0.003	0.004	0.05	0.05	0.05	0.05
CD(P=0.05)		NS	NS	NS	NS	NS	NS	0.16	NS
CV(%)		9.00	8.01	8.98	8.69	1.97	1.97	1.96	1.97
YxT					NS				NS
Initial		0.12	-	-	-	7.7	-	-	-

**Table26:Organiccarbon(%)andavailableNcontentinsoilaftercompletionofcycleasinfluencedbydifferenttreatments**

Treatments		Organiccarbon(%)				AvailableN(kgha <sup>-1</sup> )			
Greengram	Wheat	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T <sub>1</sub> :100%RDNthroughFYM	T <sub>1</sub> :75%RDNthroughVC	0.32	0.30	0.30	0.30	173	164	165	167
T <sub>2</sub> :100%RDNthroughFYM	T <sub>2</sub> :50%RDNthroughVC	0.30	0.32	0.32	0.31	164	173	170	169
T <sub>3</sub> :100%RDNthroughCC	T <sub>3</sub> :75%RDNthroughCC	0.32	0.30	0.30	0.30	173	165	164	167
T <sub>4</sub> :100%RDNthroughCC	T <sub>4</sub> :50%RDNthroughCC	0.30	0.32	0.32	0.31	165	174	172	170
S.Em.±		0.01	0.01	0.01	0.008	3.12	2.89	2.79	2.90
CD(P=0.05)		NS	NS	NS	NS	NS	NS	NS	NS
CV(%)		7.13	8.08	7.13	7.46	5.03	4.86	4.69	4.86
YxT					NS				NS
Initial		0.3	-	-	-	143	-	-	-

**Table27:Availablephosphorusandpotassiumcontentinsoilaftercompletionofcycleasinfluencedbydifferenttreatments**

Treatments		AvailableP <sub>2</sub> O <sub>5</sub> (kg/ha)				AvailableK <sub>2</sub> O(kg/ha)			
Greengram	Wheat	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T <sub>1</sub> :100%RDNthroughFYM	T <sub>1</sub> :75%RDNthroughVC	47.24	43.76	44.86	45.29	267.84	264.79	265.76	266.13
T <sub>2</sub> :100%RDNthroughFYM	T <sub>2</sub> :50%RDNthroughVC	44.86	48.15	47.21	46.74	265.76	274.10	274.11	271.33
T <sub>3</sub> :100%RDNthroughCC	T <sub>3</sub> :75%RDNthroughCC	48.45	44.73	48.15	47.01	274.16	265.76	264.91	268.28
T <sub>4</sub> :100%RDNthroughCC	T <sub>4</sub> :50%RDNthroughCC	43.78	47.23	43.51	44.84	265.66	268.89	269.03	267.86
S.Em.±		1.25	1.26	1.27	1.26	2.59	2.53	2.54	2.55
CD(P=0.05)		NS	NS	NS	NS	NS	NS	NS	NS
CV(%)		7.72	7.73	7.83	7.76	6.73	6.57	7.01	6.53
YxT		-	-	-	NS	-	-	-	NS
Initial		40.90	-	-	-	253.20	-	-	-

**Table 28: Available sulphur content in soil after completion of cycle as influenced by different treatments**

Treatments		Available S (ppm)			
Greengram	Wheat	2017	2018	2019	Pooled
T <sub>1</sub> : 100% RDN through FYM	T <sub>1</sub> : 75% RDN through VC	10.84	10.29	10.28	10.47
T <sub>2</sub> : 100% RDN through FYM	T <sub>2</sub> : 50% RDN through VC	10.28	10.54	10.60	10.47
T <sub>3</sub> : 100% RDN through CC	T <sub>3</sub> : 75% RDN through CC	10.54	10.36	10.31	10.40
T <sub>4</sub> : 100% RDN through CC	T <sub>4</sub> : 50% RDN through CC	10.31	10.83	10.73	10.62
S.Em.±		0.17	0.16	0.17	0.17
CD(P=0.05)		NS	NS	NS	NS
CV(%)		4.63	4.33	4.71	4.56
YxT		-	-	-	NS
Initial		9.8	-	-	-