Effect of organic manures on productivity of greengram-wheat cropping 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, SardarkrushinagarDantiwada 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 ofprotein, quickly growing, generate good profit for farmers and contribute to agricultural andenvironmental sustainability. Pulses constitute the major source of dietary proteinpredominantly for vegetarians of the world. Pulses are gaining more significance globally,because of its nutritional quality and suitability to various cropping systems. Among thedifferent pulses Green gram (*Vignaradiata* (L.) Wilczek), is an important cropranks third in production after Chickpea and Pigeon pea (Dixit, 2005). According to Vavilov(1926), Green gram is native of India and Central Asia[13-16]. Mungbean is also known as greengram, golden gram, mung or oregon pea. Green gram is aself-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 *et al.* 2005).The role of organic manure provides all nutrients that are required by plants but inlimited quantities. It helps in maintaining C:N ratio in the soil and also increased the fertilityand productivity of the soil. It is wellrecognizedandconsideredasabalancemanurewhich suppliesmacro and micro nutrients essential to plants. It builds up the soil micro flora, which are usefulto maintain the soil fertility. It supplies nitrogen, phosphorus, potassium and micronutrientslike Fe, S, Mo and Zn *etc*. in available form to the plants through biological decomposition andimprove 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 toevaluate the feasibility and efficiency of organic manure for improving and buildingup 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_2O_5 and 0.55 % K_2O. 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 wrigglers, 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 reach 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. Caster 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_2O_5 and 1.0 to 1.1% K_2O. 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* seasonof the years 2016-17 to 2018-19 (Three years) at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, SardarkrushinagarDantiwada 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 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.

1. Experimentaldetails **:**

Treatmentdetails:

Kharif **Greengram**	***Rabi*** **Wheat**
T_1:100%RDNthroughFYM	T_1:75%RDNthroughVC
T_2:100%RDNthroughFYM	T_2:50%RDNthroughVC
T_3:100%RDNthroughCC	T_3:75%RDNthroughCC
T_4:100%RDNthroughCC	T_4: 50% RDN through CC

Note:

1. Bio NPK consortium and bio-fertilizer was applied to both crops as seed inoculation @ 5 ml/kg of seed.
2. Experiment was conducted on fix site.
3. RDN of green gram: 20 kg N/ha and wheat: 120 kg N/ha.
4. Phosphorus will not be applied.

Design **:**Large plot technique

Replications **:**Eight

Crop and variety**:**Green gram, Gujarat mung 4, Wheat, GW 451

Spacing**:**Green gram : 45 cm Wheat : 22.5 cm

Seed rate**:**Green gram : 17.5 kg/ha Wheat : 125 kg/ha

III. RESULTS and DISCUSSION

2017-18

The data presented in Table 6 indicated that application of different organic manureshadsignificanteffectongreengramequivalentyield.Significantlythe highest greengrem equivalent yield (2136 kg/ha) was registered under treatment T_3 (100% RDN through castor cake in greengram and 75% RDN through castor cake in succeeding wheat)over rest of the treatments. However, treatment T_4 (100% RDN through castor cake in greengram and 50% castor cake in succeeding wheat) recorded significantly lower greengrem equivalent yield (1779 kg/ha) and remained at par with treatment T_2 (100% RDN through FYM in greengram and 50% RDN through vermicompost in succeeding wheat).

2018-19

Thedatatabulated inTable6revealedthatapplicationofdifferentorganic manures to greengram-wheat crop sequence had significant effect on greengram equivalentyield.Significantlythehighestgreengramequivalentyield(2629kg/ha) was registered under treatment T_3 (100% RDN through castor cake in greengram and 75% RDN through castor cake in succeeding wheat). However, treatment T_4(100%RDN through castor cake in greengram and 50% castor cake in succeeding wheat) recordedsignificantlylowergreengramequivalentyield(2247kg/ha)anddidnot differsignificantlyovertreatmentT_2(100%RDNthroughFYMingreengramand 50% RDN through vermicompost in succeeding wheat).

2019-20

The data highlighted in Table 6 revealed that application of different organic manures to greengram-wheat crop sequence had significant effect on greengram equivalent yield. Significantly the highest greengram equivalent yield (2969 kg/ha)was registered under treatment T_3 (100% RDN through castor cake in greengram and 75% RDN through castor cake in succeeding wheat). However, treatment T_4(100% RDN through castor cake in greengram and 50% castor cake in succeeding wheat) recorded significantly lower greengram equivalent yield (2446 kg/ha) but failed to differsignificantlyovertreatmentT_2(100%RDNthroughFYMingreengramand 50% RDN through vermicompost in succeeding wheat).

<u>Pooledresults</u>

Thepooleddataofthreeyears(Table6)indicatedthatapplicationofdifferent organic manures to greengram-wheat crop sequence had significant effect on greengram equivalent yield. Significantly the highest greengram equivalent yield (2578 kg/ha) was registered under treatment T_3 (100% RDN through castor cake in greengram and 75% RDN through castor cake in succeeding wheat). However, treatment T_4(100% RDN through castor cake in greengram and 50% castor cake in succeeding wheat) recordedsignificantlylowergreengramequivalentyield(2157kg/ha)andremainedat par with treatment T_2(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 resultedin saving of25% RDNfor succeeding r*abi* 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 simillar result was reported by Mahajan *et al*. (2017),Dubey*et al*. (2018), Nisha*et al*. (2018) and Panwar *et al*. (2019).

Economics

Economicsofdifferenttreatments(Table15)showedthatmaximumgross return(Rs180460/ha)andnetreturn(Rs107646/ha)withBCRof2.48wasobtained withtreatmentT_3(100%RDNthroughcastorcakeingreengramand75%RDNthroughcastorcakeinsucceedingwheat).Whichwas folloedbytreatmentT_4(100%RDN through castor cake in greengram and 50% castor cake in succeeding wheat) with net return (Rs. 82438) and BCR of 2.20.

Microbialstudies:

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 populationofsoilbacteriashowedsignificantvariationamongthetreatmentsunderinvestigation. ThetreatmentT$_3$[100%RDNthroughcastorcakeingreengram;75%RDNthrough castor cake in wheat] showed highest number of *Rhizobium, Azotobacter,* and PSB which was followed by the treatment T_4 [100% RDN through castor cake in greengram; 50%RDN through castor cake in wheat].

Chemicalstudies:

1. Nutrientcontentinseedandstoverofgreengram

The perusal of data presented in Table 17showed that treatment T_1 registered maximum N content in greengram seed on pooled basis. Whereas, significantly higher PandKcontentinseedwasobservedundertreatmentT_3 but,itwasatparwithtreatment T_1 on pooled basis. The data given in Table 18 indicated that treatment T_1 recorded significantly higher Nand P content in greengram stover but, itwas at par withtreatmentT_3onpooledbasis.While,treatmentT_3registeredsignificantlyhigherKcontentin stover, which remained at par with treatment T_1 on pooled basis.

2. N,PandKuptakebygreengramseed

The data presented in Table 19 revealed that maximum N uptake by green gramseedwasobservedundertreatmentT_3.While,significantlyhigherPuptakebygreen gram seed was registered by treatment T_3, but it was at par with treatment T_1, whereas treatment T_3 resulted in significantly thehighest K uptake by greengram seed over rest of the treatments on pooled basis.

3. N,PandKuptakebygreengramstover

The data presented in Table 20 showed that significantly higher N and P uptake by greengram stover was observed with the application of100% RDN through CC (T_3) but did not differ with treatment T_1in case of N and P uptake by green gram stover on pooled basis. However, treatment T_3 recorded significantly the highest K uptake by greengramstover.

4. Nutrientcontentinwheatgrainandstraw:

ThedatapresentedinTable21revealedthatmaximumcontentofNinwheat grain was recorded by T_1 treatment, whereas maximum content of P was registered by T_3 treatment on pooled basis. While treatment T_1 resulted in significantly higher K content (0.629%) in grain, but it was at par with treatment T_3 on pooled basis. Treatment T_1 registered significantly higher N and P content in wheat straw but, it was at par with treatmentT_3 onpooledbasis.Whereas,treatmentT_3 wasresultedinsignificantlyhigher K content in wheat straw, but it was at par with treatment T_1(Table22).

5. N,PandKuptakebywheatgrain

A perusal of data (Table 23) indicated that maximum N and P uptake by wheat grain was observed under treatment T_3 on pooled basis. Treatment T_3 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_3 on pooled basis (Table 24).

6. ECandpHofsoilaftercompletionofcycle

The data presented in Table 25 to 28 on EC, pH, organic carbon, available N, P_2O_5, K_2O 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 thatapplication of 100% recommended nitrogrn to greengram and 75% recommended nitrogen to succeeding wheat crop through castorcake for obtaining higher greengram equivalent yield and net return.

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Table1:Plantpopulationofgreengramasinfluencedbydifferenttreatments

Treatments	**Plant population per meter row length at 20 DAS**				**Plant population per meter row lengthat harvest**			
Greengram	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDN throughFYM	8.2	9.4	9.6	9.1	7.3	8.9	8.7	8.3
T_2:100%RDN throughFYM	9.8	9.1	9.7	9.4	7.6	9.0	8.7	8.4
T_3:100%RDN throughCC	9.7	9.4	9.2	9.4	7.4	9.2	8.8	8.5

T_4:100%RDN throughCC	9.5	9.4	9.4	9.4	7.8	9.1	8.4	8.4
S.Em.±	0.3	0.2	0.2	0.3	0.3	0.2	0.3	0.3
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
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			
Greengram	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDN throughFYM	45.1	50.8	52.7	49.5	4.4	5.9	6.3	5.6
T_2:100%RDN throughFYM	44.0	49.7	51.8	48.5	4.8	5.7	6.1	5.6
T_3:100%RDN throughCC	47.1	52.1	53.9	51.0	4.4	6.4	7.0	5.9
T_4:100%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	Numberofpodsperplant				Lengthofpod(cm)			
Greengram	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDN throughFYM	15.7	18.3	20.2	18.1	4.6	5.1	5.3	5.2
T_2:100%RDN throughFYM	15.6	18.0	20.1	17.9	4.4	5.3	6.1	5.3
T_3:100%RDN throughCC	17.1	20.0	22.2	19.8	4.8	5.2	5.9	5.3
T_4:100%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 grreengram as influenced by different treatments

Treatments	Seedperpod				Seedyieldperplant(g)			
Greengram	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDN throughFY M	8.7	9.5	9.5	9.2	7.1	8.2	8.4	7.9
T_2:100%RDN through FYM	8.4	9.3	9.4	9.1	7.0	8.1	8.3	7.8
T_3:100%RDN throughCC	9.9	10.9	10.7	10.5	7.3	8.5	8.6	8.2
T_4:100%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)			
Greengram	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDNthroughFYM	36.53	37.09	37.43	37.02
T_2:100%RDNthroughFYM	35.68	36.39	37.35	36.47
T_3:100%RDNthroughCC	36.86	37.54	37.38	37.39
T_4:100%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)			
Greengram	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDN throughFY M	415	490	536	480	862	948	1078	963
T_2:100%RDN through FYM	410	495	523	475	812	1009	1075	965
T_3:100%RDN throughCC	420	514	552	495	906	1036	1025	989
T_4:100%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	10.0	7.13	7.95	28.09

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YxT	-	-	-	NS	-	-	-	NS

Table7:Plantpopulationofwheatasinfluencedbydifferenttreatments

Treatments	Plant population at 20 DAS				Plant population at harvest			
Wheat	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:75%RDN throughVC	26.0	26.3	26.8	26.3	24.4	24.6	24.6	24.6
T_2:50%RDN throughVC	26.0	25.4	26.3	25.9	24.6	23.6	24.1	24.1
T_3:75%RDN throughCC	26.3	26.6	27.0	26.6	24.8	25.6	25.5	25.3
T_4:50%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			
Wheat	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:75%RDN throughVC	68.1	71.0	72.8	70.6	4.1	4.3	4.8	4.4
T_2:50%RDN throughVC	62.7	65.3	69.3	65.8	3.8	4.0	4.2	4.0
T_3:75%RDN throughCC	74.8	77.5	80.2	77.5	4.7	5.0	5.569	5.1
T_4:50%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			
Wheat	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:75%RDN throughVC	6.7	7.0	7.3	7.0	11.7	12.8	13.6	12.7
T_2:50%RDN throughVC	6.0	6.6	6.6	6.4	10.7	11.8	12.9	11.8
T_3:75%RDN throughCC	7.4	7.8	8.2	7.8	13.0	14.2	15.3	14.2
T_4:50%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)			
Wheat	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:75%RDN throughVC	36.38	37.20	39.10	37.56	40.13	40.38	41.06	40.52
T_2:50%RDN throughVC	30.24	31.98	33.46	31.89	39.94	39.38	39.38	39.56
T_3:75%RDN throughCC	39.95	41.69	43.19	41.61	40.25	40.63	41.93	40.94
T_4:50%RDN throughCC	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

Table11:Grainyieldofwheatasinfluencedbydifferenttreatments

Treatments	Grainyield(kg/ha)				Strawyield((kg/ha)			
Wheat	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:75%RDN throughVC	3213	4396	3913	3841	5266	5472	5337	5358
T_2:50%RDN throughVC	2899	4116	3660	3559	4654	4813	4740	4736
T_3:75%RDN throughCC	3550	4795	4389	4245	5688	5975	5874	5845
T_4:50%RDN throughCC	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

Table12:Greengramequivalentyieldasinfluencedbydifferenttreatments

Treatments		Greengramequivalentyield(kg/ha)			
Greengram	Wheat	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDN throughFYM	T_1:75%RDN throughVC	1965	2430	2703	2366
T_2:100%RDN throughFYM	T_2:50%RDN throughVC	1824	2304	2535	2221
T_3:100%RDN throughCC	T_3:75%RDN throughCC	2136	2629	2969	2578
T_4:100%RDN throughCC	T_4:50%RDN throughCC	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:Economicsof*kharif*greengramasinfluencedbydifferenttreatments (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_1:100%RDNthroughFYM	480	963	35526	28400	7126	1.25
T_2:100%RDNthroughFYM	475	965	35180	28400	6780	1.24
T_3:100%RDNthroughCC	495	989	36628	24544	12084	1.49
T_4:100%RDNthroughCC	487	1021	36132	24544	11588	1.47

Rateofdifferentinput:

(i) FYM :Rs1.50/kgiii)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_1:75%RDNthroughVC	3841	5358	85212	60790	24422	1.40
T_2:50%RDNthroughVC	3559	4736	78270	52530	25740	1.49
T_3:75%RDNthroughCC	4245	5845	93945	48270	45675	1.95
T_4:50%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_1:100%RDN throughFYM	T_1:75%RDN throughVC	2366	165620	89190	76430	1.86
T_2:100%RDN throughFYM	T_2:50%RDN throughVC	2221	155470	80930	74540	1.92
T_3:100%RDN throughCC	T_3:75%RDN throughCC	2578	180460	72814	107646	2.48
T_4:100%RDN throughCC	T_4:50%RDN throughCC	2157	150990	68552	82438	2.20

Rateofdifferentinput:

(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:Soilpopulationof*Rhizobium*,*Azotobacter*andPSBingreengram-wheatbasedcroppingsequence

Treatments	Populationofmicroorganismsinsoil(x10^{5}CFU/gofsoil)																							
	Greengram												Wheat											
	Rhizobium				*Azotobacter*				PSB				*Rhizobium*				*Azotobacter*				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_1	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_2	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_3	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_4	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±	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

*****PopulationofmicroorganismsinsoilareexpressedintermsofCFU(CFU=ColonyFormingUnits)/gmofsoil

Table17:N,PandKcontentingreengramseedasinfluencedbydifferenttreatments

Treatments	Ncontent(%)				Pcontent(%)				Kcontent(%)			
Greengram	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDN throughFYM	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_2:100%RDN throughFYM	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_3:100%RDN throughCC	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_4:100%RDN throughCC	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.±	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 xT				NS				NS				NS

Table18: N,PandKcontentinstoverofgreengramasinfluencedbydifferenttreatments

Treatments	Ncontent(%)				Pcontent(%)				Kcontent(%)			
Greengram	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T_1:100%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_2:100%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_3:100%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_4:100%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)				Kuptake(kg/ha)			
Greengram	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T_1:100%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_2:100%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_3:100%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_4:100%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)			
Greengram	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T_1:100%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_2:100%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_3:100%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_4:100%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(%)			
Wheat	2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
T_1:75%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_2:50%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_3:75%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_4:50%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_1:75%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_2:50%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_3:75%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_4:50%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)				Puptake(kg/ha)				Kuptake(kg/ha)			
Wheat	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:75%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_2:50%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_3:75%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_4:50%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_1:75%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_2:50%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_3:75%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_4:50%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:ECandpHofsoilaftercompletionofcycleasinfluencedbydifferenttreatments

Treatments		**EC(dSm^{-1})**				**pH**			
Greengram	Wheat	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDNthroughFYM	T_1:75%RDNthroughVC	0.12	0.11	0.11	0.12	7.70	7.74	7.67	7.70
T_2:100%RDNthroughFYM	T_2:50%RDNthroughVC	0.13	0.12	0.13	0.13	7.80	7.63	7.84	7.75
T_3:100%RDNthroughCC	T_3:75%RDNthroughCC	0.12	0.11	0.11	0.12	7.63	7.80	7.63	7.68
T_4:100%RDNthroughCC	T_4:50%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^{-1})			
Greengram	**Wheat**	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDNthrough FYM	T_1:75%RDNthroughVC	0.32	0.30	0.30	0.30	173	164	165	167
T_2:100%RDNthrough FYM	T_2:50%RDNthroughVC	0.30	0.32	0.32	0.31	164	173	170	169
T_3:100%RDNthroughCC	T_3:75%RDNthrough CC	0.32	0.30	0.30	0.30	173	165	164	167
T4:100%RDNthroughCC	T_4:50%RDNthrough CC	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_2O_5(kg/ha)				AvailableK_2O(kg/ha)			
Greengram	**Wheat**	**2017**	**2018**	**2019**	**Pooled**	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDNthroughFYM	T_1:75%RDNthroughVC	47.24	43.76	44.86	45.29	267.84	264.79	265.76	266.13
T_2:100%RDNthroughFYM	T_2:50%RDNthroughVC	44.86	48.15	47.21	46.74	265.76	274.10	274.11	271.33
T_3:100%RDNthroughCC	T_3:75%RDNthroughCC	48.45	44.73	48.15	47.01	274.16	265.76	264.91	268.28
T_4:100%RDNthroughCC	T_4:50%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	-	-	-

Table28:Availablesulphurcontentinsoilaftercompletionofcycleasinfluencedbydifferenttreatments

Treatments		20	AvailableS(ppm)		
Greengram	Wheat	**2017**	**2018**	**2019**	**Pooled**
T_1:100%RDNthroughFYM	T_1:75%RDNthroughVC	10.84	10.29	10.28	10.47
T_2:100%RDNthroughFYM	T_2:50%RDNthroughVC	10.28	10.54	10.60	10.47
T_3:100%RDNthroughCC	T_3:75%RDNthroughCC	10.54	10.36	10.31	10.40
T_4:100%RDNthroughCC	T_4:50%RDNthroughCC	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	-	-	-