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Influence of conservation tillage practices and nutrient management on yield attributes and yield of greengram in greengram-wheat cropping sequence

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Abstract
An investigation was carried out at Post Graduate Institute Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra (India) on "Influence of conservation tillage practices and nutrient management on soil health and productivity of greengram– wheat cropping sequence" was conducted during 2019-20 and 2020-21. The soil of experimental field was sandy loam in texture. The experiment was laid out in split plot design during *kharif* season and split-split plot design during *rabi* season with three replications. The treatment consists of six main plot treatments of conservation tillage practices *viz*., T_1– Conventional tillage with crop residue, T_2 – Conventional tillage without crop residue, T_3 – Minimum tillage with crop residue, T_4 – Minimum tillage without crop residue, T_5 – Zero tillage with crop residue, T_6 – Zero tillage without crop residue and two sub plot treatments of nutrient management *viz*., F_1 – 75% GRDF, F_2 – 100% GRDF for *kharif* greengram during two consecutive years. The result revealed that mean higher yield attributes and yield *viz*., number of pods plant^{-1} (17.73/19.60/18.66 during first year, second year and on pooled mean basis respectively), pods weight plant^{-1} (14.26/16.28/15.27 g during first year, second year and on pooled mean basis respectively), number of seed pod^{-1} (8.56/8.79/8.67 first year, second year and on pooled mean basis respectively), seed weight plant^{-1} (9.40/10.26/9.83 g first year, second year and on pooled mean basis respectively), 100 seed weight (6.12/6.35/6.23 g first year, second year and on pooled mean basis respectively), seed yield (13.12/14.23/13.68 q ha^{-1} first year, second year and on pooled mean basis respectively), straw yield (29.69/31.05/30.37 q ha^{-1} first year, second year and on pooled mean basis respectively) and harvest index (30.51/31.29/30.90% first year, second year and on pooled mean basis respectively) recorded under conservation tillage practice minimum tillage with crop residue with 100% GRDF to *kharif* greengram.

Keywords: Conservation tillage practices, nutrient management, yield attributes, yield, greengram

Introduction

Greengram (*Vigna radiata* L. Wilczek) is one of the important pulse crop in India. It is also known as mungbean, moong and golden gram. Mainly cultivated in arid and semi-arid region. It is believed that greengram is a native of India and Central Asia. Greengram is a protein rich staple food. It contains about 25% protein, which is almost three times that of cereals. It supplies protein requirement of vegetarian population of the country. It is particularly rich in Leucine, Phenylalanine, Lysine, Valine, Isoleucine, etc. In addition to being an important source of human food and animal feed, it also plays an important role in sustaining soil fertility by improving soil physical properties and fixing atmospheric nitrogen. The leading greengram producing states in India are Rajasthan, Maharashtra and Andhra Pradesh.

Conservation agriculture is a resource-saving agricultural production system that aims to achieve production intensification and high yields while enhancing the natural resource base through compliance with three interrelated principles i.e. minimum soil disturbance with organic soil cover and diversified crop rotation along with other good production practices of plant nutrition and pest management (Abrol and Sangar, 2006) [1]. Conservation agriculture (CA), a concept evolved as a response to concerns of sustainability of agriculture globally, has steadily increased worldwide to cover about 8% of the world arable land (124.8 M ha). Conservation agriculture offers an opportunity for arresting and reversing the downward spiral of resource degradation, decreasing cultivation costs and making agriculture more resource-use-efficient, competitive and sustainable "Conserving resources – enhancing productivity" has to be the new mission (Bhan and Behera, 2014) [6]. Hence there is scope for obtaining sustainable production by growing predominant pulse crop greengram during *kharif* season.

Therefore, effort has been made to plan and examine an experiment on "Influence of conservation tillage practices and nutrient management on soil health and productivity in greengram – wheat cropping sequence".

Materials and Methods

The field experiment was conducted during *kharif* season 2019 and 2020 at the Research Farm of Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.), situated at 19^0 48'N and 19^0 57'N Latitude and 74^0 32'E and 74^0 19'E longitude and altitude is 511 m above mean sea level. The topography of experimental field was levelled and well drained. The meteorological data on important weather parameters during the crop growth period for the year 2019 and 2020 was recorded at Meteorological Observatory located at AICRP on Irrigation Water Management Project, M.P.K.V., Rahuri. The experiment was conducted in split plot design with three replications during *kharif* season in a fixed layout. The treatment consists of six main plot treatments of conservation tillage practices *viz*., T_1 - Conventional tillage with crop residue, T_2 - Conventional tillage without crop residue, T_3 - Minimum tillage with crop residue, T_4 - Minimum tillage without crop residue, T_5 – Zero tillage with crop residue, T_6 - Zero tillage without crop residue and two sub plot treatments of nutrient management *viz*., F_1 - 75% GRDF, F_2 - 100% GRDF for *kharif* greengram during two consecutive years. In case of Conventional tillage one ploughing, disking and planking and in case of minimum tillage disking was carried out. The gross plot size was 8.10 m x 4.80 m. The greengram variety Phule Vaibhav was grown at row to row spacing 30 cm and plant to plant spacing 10 cm by using seed rate 15 kg ha^{-1}. The 5 t FYM was applied before sowing, while recommended dose of fertilizer @ 20:40:00 kg N, P_2O_5, K_2O ha^{-1} given in the form of urea and single super phosphate respectively during 2019 and 2020. In greengram Pendimethalin 30 EC @ 1 to 1.5 kg A.I. ha^{-1} was applied as pre-emergence followed by two hand weeding at 15 DAS and 35 DAS followed by application of Imazethapyr 10% SL @ 0.1 to 0.15 kg A.I. at 21 DAS in zero tillage plot during both the years of study.

Results and Discussion

Number of pods plant^{-1}

Effect of conservation tillage practices

The Conservation tillage practice minimum tillage with crop residue (T_3) to greengram crop registered significantly higher number of pods plant^{-1} (20.03, 22.97 and 21.50 respectively) in greengram than rest of the conservation tillage practices during both the years and on pooled mean basis (Table 1.). However, it was at par with conservation tillage practice conventional tillage with crop residue (T_1) during both the year and on pooled mean basis. The number of pods plant^{-1} were obtained maximum in treatment conservation tillage practice minimum tillage with crop residue (T_3) might be due to maximum increase in physico-chemical and biological properties of soil, enhanced growth parameters and plant biomass with efficient and greater, partitioning of metabolites towards reproductive structures and conversion of flowers in pods with the support of more conserved soil moisture at peak period of pod initiation might have resulted in increased number of pods plant^{-1} These results are in conformity with those reported by Amanullah *et al*. (2012) [3], Prajapati *et al*. (2020) [15] and Yadav *et al*. (2020) [21].

Effect of nutrient management

Data presented in Table 1. Reported that the 100% GRDF (F_2) recorded significantly higher number of pods plant^{-1} (18.60, 20.11 and 19.36) during both year and on pooled mean basis, respectively. The application of 100% GRDF (F_2) recorded maximum number of pods plant^{-1} because all the growth attributes were higher due to availability of congenial soil environment in the root zone of crop and adequate supply of nutrients through recommended dose of fertilizers might be attributed better supply of nutrients leading to better root activity and higher nutrient absorption which results better yield attributes. These results are confirmed by Shete *et al*. (2010) [18] and Pandiaraj (2017) [13].

Pod weight plant^{-1} (g)

Effect of conservation tillage practices

Data presented in Table 1. showes that Conservation tillage practice minimum tillage with crop residue (T_3) to greengram crop registered significantly maximum pod weight plant^{-1} (17.04, 19.50 and 18.27 g, respectively) than rest of the conservation tillage practices during both the years and on pooled mean basis. Maximum pod weight plant^{-1} with conservation tillage practice minimum tillage with crop residue (T_3) might be due to availability of soil moisture in the root zone, and uptake of more nutrient causes the higher growth characteristics that were followed by more synthesis and transfer of food material to the source may have led to larger seeds and consequently, more weight of pods plant^{-1}. These results are in conformity with those reported by Banjara *et al*. (2017) [5] and Prajapati *et al*. (2020) [15].

Effect of nutrient management

The 100% GRDF (F_2) recorded significantly maximum pod weight plant^{-1} during both year and pooled mean basis (15.50, 17.10 and 16.30 g) than 75% GRDF (F_1) (Table 1.) Higher pod weight plant^{-1} recorded in 100% GRDF (F_2) due to balanced nutrition increase the uptake of essential nutrients which help for increasing the growth and yield attributes of crop. These results were confirmed by Rathod and Gawande (2014) [16] and Dongare *et al*. (2016) [9].

Number of seeds pod^{-1}

Effect of conservation tillage practices

Data presented in Table 2. expressed that the conservation tillage practice minimum tillage with crop residue (T_3) to greengram crop registered significantly maximum numbers of seeds pod^{-1} (9.83, 9.93 and 9.88 respectively) than rest of the conservation tillage practices during both the years and on pooled mean basis. Maximum numbers of seeds pod^{-1} with conservation tillage practice minimum tillage with crop residue (T_3) might be due to having conserved higher soil moisture leading to better soil conditions and thereby improving the availability of essential nutrients help for increasing the yield contributing character in terms of numbers of seeds pod^{-1}. These results are in conformity with those reported by Banjara *et al*. (2017) [5] and Yadav *et al*. (2020) [21].

Effect of nutrient management

Data presented in Table 2. Implicated that the 100% GRDF (F_2) recorded significantly higher number of seeds pod^{-1} (9.02, 9.17 and 9.09) than 75% GRDF (F_1) during both the years. The 75% GRDF (F_1) registered significantly minimum number of seeds pod^{-1} (8.09, 8.41 and 8.23) during both the years. Maximum numbers of seeds pod^{-1} recorded at 100% GRDF (F_2) might be due to sufficient supply of N and P to plant for remarkable improvement in the various growth parameters and yield attributes, which ultimately resulted in maximum number of seeds pod^{-1} These results are supported by Jat *et al*. (2012) [10], Kundu *et al*. (2013) [11] and Patel *et al*. (2018) [14].

Seed weight plant^{-1} (g)

Effect of conservation tillage practices

Conservation tillage practice minimum tillage crop residue (T_3) to greengram crop registered significantly higher seed weight plant^{-1} (11.05, 12.12 and 11.59 g, respectively) than rest of the conservation tillage practices during both the years and on pooled mean basis. However, it was at par with conservation tillage practice conventional tillage with crop residue (T_1) during both of year and on pooled mean basis. Higher seed weight plant^{-1} recorded under minimum tillage crop residue (T_3) might be due to greater growth and development with the help of retained soil moisture, improved nutrient efficiency and good aeration. These results are in agreement with those reported by Miyazawa *et al*. (2004) [12].

Effect of nutrient management

The 100% GRDF (F_2) recorded significantly higher seed weight plant^{-1} during both year and on pooled mean basis (10.33, 11.15 and 10.74 g) than 75% GRDF (F_1) (Table 2.). Maximum seed weight plant^{-1} with nutrient management practices at 100% GRDF (F_2) might be due to balance application fertilizer dose to crop achieve more vegetative growth which increases the interception of light and uptake of nutrient helps for production of photosynthates and its translocation from source to sink. These results are resembled with Rathod and Gawande (2014) [16] and Dongare *et al*. (2016) [9].

100 seed weight (g)

Effect of conservation tillage practices

The Conservation tillage practice minimum tillage with crop residue (T_3) to greengram crop registered significantly maximum 100 seed weight (7.12, 7.35 and 7.23 g, respectively) than rest of the conservation tillage practices during both the years and on pooled mean basis (Table 2.). However, it was at par with conservation tillage practice conventional tillage with crop residue (T_1) during second year. The 100 seed weight increased due to conserving more moisture and mineralization of nutrient in minimum tillage and residue management practices which helps to increase the grain size and ultimately increases 100 seed weight. Similar results were reported by Amanullah *et al*. (2012) [3] and Asha *et al*. (2016) [4].

Effect of nutrient management

The 100% GRDF (F_2) recorded significantly maximum 100 seed weight (6.45, 6.71 and 6.58 g, respectively) than 75% GRDF (F_1) during both the years and on pooled mean basis. Maximum 100 seed weight with nutrient management practices at 100% GRDF (F_2) might be due the increased supply of the major nutrients (NPK) causes the translocation and accumulation of photosynthates in the economic sinks, resulted in increased grain weight. Similar trend was reported by Pandiaraj *et al*. (2017) [13], Patel *et al*. (2018) [14] and Somalraju *et al*. (2021) [20].

Seed yield (q ha^{-1})

Effect of conservation tillage practices

Data presented in Table 3. indicated that the Conservation tillage practice minimum tillage with crop residue (T_3) to greengram crop registered significantly higher seed yield (15.32, 17.05 and 16.18 q ha^{-1}, respectively) than rest of the conservation tillage practices during both the years and on pooled mean basis. However, it was at par with conservation tillage practice conventional tillage with crop residue (T_1) during second year and on pooled mean basis. The maximum seed yield was obtained with conservation tillage practice minimum tillage with crop residue (T_3) might be due to proper seed bed with increased pore space, light interception and more moisture retained resulted in higher growth and yield attributes, physiological and biochemical processes of plant. This ultimately led to greater greengram yield. These results are in corroborated with the results reported by Amanullah *et al*. (2012) [3], Ali *et al*. (2013) [2], Dasharath *et al*. (2016) [7] and Yadav *et al*. (2020) [21].

Effect of nutrient management

Data presented in Table 3. concluded that The 100% GRDF (F_2) recorded significantly higher seed yield (13.71, 14.95 and 14.33 q ha^{-1}) during both of the year and on pooled mean basis than 75% GRDF (F_1). Maximum seed yield recorded in 100% GRDF (F_2) due to cumulative effect exerted from better improvement in drainage, soil environment, aeration, root development, N fixation by bacteria, optimum moisture-air equilibrium throughout the crop growth besides supply of balanced fertilizer application provided better nourishment to plant for better partitioning dry matter to the crop resulting in better growth and development ultimately reflected in better seed yield. These results are in resembled with Shete *et al*. (2010) [18], Shelke *et al*. (2012) [17], Pandiaraj *et al*. (2017) [13] and Patel *et al*. (2018) [14].

Straw yield (q ha^{-1})

Effect of conservation tillage practices

Conservation tillage practice minimum tillage with crop residue (T_3) to greengram crop registered significantly higher straw yield (32.57, 34.78 and 33.67 q ha^{-1}, respectively) than rest of the conservation tillage practices during both the years and on pooled mean basis. However, it was at par with conservation tillage practice conventional tillage with crop residue (T_1) during second year and pooled mean basis. Higher straw yield under minimum tillage with crop residue (T_3) might be due to greater moisture and nutrient uptake by plants as a result of improved soil conditions led to maximum growth and yield characteristics, which were represented in higher total biomass production by crop. These results are in conformity with those reported by Banjara *et al*. (2017) [5], Prajapati *et al*. (2020) [15] and Yadav *et al*. (2020) [21].

Effect of nutrient management

The 100% GRDF (F_2) recorded significantly higher straw yield (30.00, 32.21 and 31.11 q ha^{-1}, respectively) than 75% GRDF (F_1) during first year, second year and on pooled mean basis (Table 3.). Higher straw yield recorded in 100% GRDF (F_2) due to the application GRDF might have attributed to the higher photosynthetic activity in crop plant leading to a better supply of carbohydrates resulted in more number of branches and dry matter which resulted higher straw yield. These results are resembled with those reported by Kundu *et al.* (2013) [11], Sindhi *et al.* (2016) [19], Patel *et al.* (2018) [14] and Desai *et al.* (2020) [8].

Harvest index (%)

Effect of conservation tillage practices

Data presented in Table 3. showed that the Conservation tillage practice minimum tillage with crop residue (T_3) to greengram crop registered significantly higher harvest index (31.97, 32.96 and 32.46%, respectively) than rest of the conservation tillage practices during both the years and on pooled mean basis. However, it was at par with conservation tillage practice conventional tillage with crop residue (T_1) during both of the year and on pooled mean basis and zero tillage with crop residue (T_5) during second year. Higher harvest index in conservation tillage practice minimum tillage with crop residue (T_3) due to more soil moisture causes more production of total biomass and its mobilization into grains of crop. These results are in conformity with those reported by Prajapati *et al.* (2020) [15] and Yadav *et al.* (2020) [21].

Effect of nutrient management

Data presented in Table 3. Shows that harvest index of greengram was influenced significantly due to different nutrient management treatment during first year, second year and on pooled mean basis. The 100% GRDF (F_2) recorded significantly higher harvest index (31.27, 31.55 and 31.41%, respectively) than 75% GRDF (F_1) during both the years and on pooled mean basis. Higher harvest index in nutrient management practices at 100% GRDF (F_2) due to application of recommended dose of NPK increases seed yield and straw yield and ultimately increases the harvest index. These results are supported the results obtained by Kundu *et al.* (2013) [11] and Desai *et al.* (2020) [8].

Table 1: Number of pods plant^{-1} and Pod weight plant^{-1} (g) of greengram as influenced by different treatments

Treatment	Number of pods plant^{-1}			Pod weight plant^{-1} (g)		
	2019	2020	Pooled	2019	2020	Pooled
Conservation tillage practices –(T)						
T_1: Conventional tillage with crop residue	19.67	21.90	20.78	15.91	18.00	16.95
T_2: Conventional tillage without crop residue	16.03	17.73	16.88	12.84	14.63	13.74
T_3: Minimum tillage with crop residue	20.03	22.97	21.50	17.04	19.50	18.27
T_4: Minimum tillage without crop residue	17.77	19.43	18.60	13.24	15.37	14.31
T_5: Zero tillage with crop residue	18.20	20.27	19.23	14.82	17.51	16.16
T_6: Zero tillage without crop residue	14.67	15.30	14.98	11.73	12.69	12.21
SEm ±	0.22	0.52	0.35	0.27	0.47	0.33
CD (P=0.05)	0.70	1.63	1.02	0.84	1.49	0.98
Nutrient Management – (F)						
F_1: 75% GRDF	16.86	19.09	17.80	13.03	15.47	13.99
F_2: 100% GRDF	18.60	20.11	19.36	15.50	17.10	16.30
SEm ±	0.18	0.31	0.18	0.25	0.27	0.18
CD (P=0.05)	0.55	0.95	0.52	0.76	0.85	0.54
Interactions (T x F)						
Between two sub plots means at same level of main plot means						
SEm ±	0.43	0.75	0.43	0.60	0.67	0.45
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Between two main plots means at same level of sub plot means						
SEm ±	0.49	1.04	0.57	0.62	0.94	0.56
CD (P=0.05)	NS	NS	NS	NS	NS	NS
General mean	17.73	19.60	18.66	14.26	16.28	15.27

Table 2: Number of seeds pod^{-1}, Seed weight plant^{-1} (g) and 100 seed weight (g) of greengram as influenced by different treatment

Treatment	Number of seeds pod^{-1}			Seed weight plant^{-1} (g)			100 seed weight (g)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Conservation tillage practices –(T)									
T_1: Conventional tillage with crop residue	9.30	9.50	9.40	10.90	11.60	11.25	6.70	6.98	6.84
T_2: Conventional tillage without crop residue	7.77	7.90	7.83	8.47	9.20	8.83	5.43	5.70	5.57
T_3: Minimum tillage with crop residue	9.83	9.93	9.88	11.05	12.12	11.59	7.12	7.35	7.23
T_4: Minimum tillage without crop residue	8.40	8.70	8.55	8.75	9.58	9.16	5.86	6.00	5.93
T_5: Zero tillage with crop residue	8.80	8.93	8.87	9.29	10.71	10.00	6.45	6.59	6.52
T_6: Zero tillage without crop residue	7.23	7.77	7.50	7.96	8.34	8.15	5.15	5.45	5.30
SEm ±	0.14	0.12	0.12	0.08	0.20	0.13	0.05	0.15	0.09
CD (P=0.05)	0.45	0.38	0.34	0.26	0.62	0.39	0.14	0.46	0.28
Nutrient Management – (F)									
F_1: 75% GRDF	8.09	8.41	8.23	8.48	9.37	8.29	5.79	5.98	6.01
F_2: 100% GRDF	9.02	9.17	9.09	10.33	11.15	10.74	6.45	6.71	6.58
SEm ±	0.12	0.22	0.13	0.25	0.24	0.17	0.20	0.16	0.13
CD (P=0.05)	0.38	0.69	0.37	0.78	0.73	0.51	0.62	0.49	0.37
Interactions (T x F)									
Between two sub plots means at same level of main plot means									
SEm ±	0.30	0.54	0.31	0.62	0.58	0.42	0.49	0.38	0.31

CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Between two main plots means at same level of sub plot means									
SEm ±	0.32	0.44	0.27	0.46	0.53	0.35	0.35	0.37	0.25
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
General mean	8.56	8.79	8.67	9.40	10.26	9.83	6.12	6.35	6.23

Table 3: Seed yield, straw yield and harvest index of greengram as influenced by different treatments

Treatment	**Seed yield (q ha^{-1})**			**Straw yield (q ha^{-1})**			**Harvest index (%)**		
	2019	**2020**	**Pooled**	**2019**	**2020**	**Pooled**	**2019**	**2020**	**Pooled**
Conservation tillage practices –(T)									
T_1: Conventional tillage with crop residue	14.95	16.30	15.63	31.89	33.52	32.71	31.92	32.75	32.34
T_2: Conventional tillage without crop residue	11.75	12.94	12.34	28.20	29.97	29.09	29.39	29.96	29.68
T_3: Minimum tillage with crop residue	15.32	17.05	16.18	32.57	34.78	33.67	31.97	32.96	32.46
T_4: Minimum tillage without crop residue	12.40	13.70	13.05	29.50	30.87	30.19	29.57	30.74	30.16
T_5: Zero tillage with crop residue	13.94	14.42	14.18	30.45	31.11	30.78	31.40	31.67	31.53
T_6: Zero tillage without crop residue	10.35	11.00	10.67	25.53	26.05	25.79	28.81	29.69	29.25
SEm ±	0.11	0.43	0.27	0.20	0.77	0.49	0.17	0.42	0.23
CD (P=0.05)	0.35	1.37	0.81	0.63	2.44	1.44	0.52	1.32	0.72
Nutrient Management – (F)									
F_1: 75% GRDF	12.52	13.51	13.02	29.38	29.89	29.36	29.75	31.04	30.40
F_2: 100% GRDF	13.71	14.95	14.33	30.00	32.21	31.11	31.27	31.55	31.41
SEm ±	0.08	0.27	0.14	0.15	0.75	0.38	0.21	0.13	0.14
CD (P=0.05)	0.25	0.84	0.42	0.48	2.32	1.12	0.65	0.41	0.42
Interactions (T x F)									
Between two sub plots means at same level of main plot means									
SEm ±	0.20	0.67	0.34	0.37	1.84	0.94	0.52	0.32	0.33
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Between two main plots means at same level of sub plot means									
SEm ±	0.23	0.88	0.46	0.43	1.86	0.95	0.46	0.76	0.46
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
General mean	13.12	14.23	13.68	29.69	31.05	30.37	30.51	31.29	30.90

Conclusion

Based on two years of experimentation it could be concluded that the Conservation tillage practice minimum tillage with crop residue (T_3) and 100% GRDF (F_2) to *kharif* greengram obtained higher yield parameters *viz*., number of pods $plant^{-1}$, pods weight $plant^{-1}$, number of seed pod^{-1}, seed weight $plant^{-1}$, 100 seed weight, seed yield, straw yield and harvest index in greengram-wheat cropping sequence.

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