RESEARCH ARTICLE

EVALUATION THE RESIDUAL EFFECT OF CROPPING SYSTEM AND INTEGRATED NITROGEN MANAGEMENT ON SUMMER GREENGRAM (*VIGNA RADIATA* L.) IN WINTER MAIZE BASED CROPPING SYSTEM UNDER IRRIGATED CONDITION

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Abstract: A field experiment was conducted during rabi and summer seasons of 2013-14 and 2014-15 at Student's Instructional Farm Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (Uttar Pradesh) to find out the residual effect of integrated nitrogen management (INM) and cropping system on summer greengram in winter maize based cropping system under irrigated condition. The experiment consisted of four sole cropping (sole maize, sole potato, sole linseed and sole mustard), three intercropping systems (maize + potato, maize + mustard in 3:1 row ratio and maize + linseed grown in 3:3 row ratio) and three INM practices, viz. 100% recommended dose of nitrogen (100% RDN), 75% RDN through inorganics + 25% RDN through organics (75 + 25% RDN), and 50% RDN through inorganics + 50% RDN through organics (50 + 50% RDN). The residual effect of cropping system on growth attributes of succeeding greengram such as dry matter accumulation/plant and branches/plant, yield attributes of greengram viz., pods/plant, grains/pod, grain weight/pod, grain weight/plant and 1000-grain weight and nodules/plant and their dry weight, were recorded higher values when grown after sole potato and maize + potato in 3:1 row ratio respectively, closely followed by grown after sole linseed and plots cultivated with maize + linseed respectively, during both the years over rest of the cropping system. Grain and stover yield of succeeding greengram crop were maximized when grown after sole cropping of potato, followed by sole linseed in both the years. The corresponding values, on an average, were 0.934 and 1.417 t/ha and 0.923 and 1.398 t/ha for grain and stover yield of greengram grown after potato and linseed, respectively. Among intercropping cultivated plots, greengram grown after maize + potato recorded, on an average, higher grain yield (0.906 t/ha) and stover yield (1.359 t/ha) over greengram grown after other intercropping systems. Greengram grown after maize + linseed and maize + mustard recorded similar values of grain and stover yield. Harvest index of greengram was maximized when grown after maize + mustard intercropping system (40.56% on mean basis). Minimum harvest index of 39.51% on mean basis was recorded when greengram grown after maize + linseed intercropping system. Similar the residual effect of integrated nitrogen management (INM) on growth attributes, yield attributing characters, Number of nodules/plant and their dry weight of greengram were maximized when grown in previously fertilized plots with 50% N through inorganic urea + 50% N through organics, followed by 75% inorgainc + 25% RDN through organic in both the seasons. Previously fertilized plots with 50% N through inorganic urea + 50% N through organics recorded significantly higher values of biological (2.413 t/ha) as well as grain yield (0.973 t/ha) of greengram over remaining INM protocols. Similar trends were followed in respect of stover yield of greengram. On an average, maximum harvest index (40.30%) of greengram was recorded when grown after 50% N through inorganic urea + 50% N through organics fertilized plots, followed by 100% RDN through inorganic fertilized plots (40.03%).

Keywords: Cropping system, Integrated nitrogen management, Residual effect, *Vigna radiata* L.

INTRODUCTION

Greengram (*Vigna radiata* L.Wilczek) known as mung or mungbean in India, is the third important pulse crop of India after chickpea and pigeonpea. It is considered as wholesome among pulses, free from heaviness and flatulence. Besides its utilization as food in many forms, haulms are used as fodder and green manure. Due to its shorter duration, it can be fitted in several multiple cropping systems. Just like other pulse crops, inclusion of greengram in cropping system improves soil health and fertility (**Reddy 2009**). The seed of greengram contain 24.7% protein, 0.6% fat, 0.9% fibre and 3.7% ash (**Mohanty *et al.*, 2014**). The total area covered under greengram in India was 30.41 lakh hectares with a total production of 14.24 lakh tonnes during twelfth Plan **(Tiwari and Shivhare)**.

Summer greengram is especially help in sustaining the productivity levels of maize- greengram cropping system. The productivity of the system primarily depends on appropriate nutrient management practices. .The judicious combination of organic and inorganic sources of nitrogen in the maize-greengram cropping system was quite suitable to maintain soil fertility and productivity. Organic sources like farm yard manure and vermicompost are not only the storehouse of plant nutrient but also improve the physical-chemical properties of soil. Greengram enriches the soil through biological nitrogen fixation and organic residues. The crop is grown on marginal lands with low inputs particularly fertilizers and moisture and thus it is most suitable crop grown on residual fertility. Keeping this in view, study the application of organic sources of nitrogen with inorganic fertilizer in different maize- based

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cropping system on the especially aspects of residual effect on growth and yield of succeeding greengram has been planned (**Puste *et al.*, 2001**)

MATERIALS AND METHODS

A field experiment was conducted at Students' Instructional Farm of C.S. Azad University of Agriculture and Technology, Kanpur, which is situated in the alluvial tract of Indo - Gangetic plains in central part of Uttar Pradesh between 25^0 26' to 26^0 58' North latitude and 79^0 31' to 80^0 34' East longitude at an elevation of 125.9 metres from the sea level during winter and summer seasons of 2013–14 and 2014–15 respectively. There were 21 treatment combinations comprising three intercropping systems (maize + potato, maize + mustard in 3:1 and maize + linseed grown in 3:3 row ratio), four sole cropping of maize, potato, mustard and linseed, and three integrated nitrogen management-INM practices, viz. 100% recommended dose of nitrogen (100% + 0% RDN), 75% RDN through inorganics + 25% RDN through organics (75% + 25% RDN), and 50% RDN through inorganics + 50% RDN through organics (50% + 50% RDN). These treatments were assigned in split plot design keeping 7 cropping systems in main plot and 3 INM practices in sub-plots with 3 replications. The soil was sandy loam in texture, low in organic carbon and available nitrogen, medium in available phosphorus and available potassium with slightly alkaline in reaction. The rows were oriented east-west. The rainfall during the crop season was 5.0 mm in 2013-14 and 40.8 mm in 2014-15. All crops were fertilized with recommended dose of NPK @ 150:75:60 kg for maize, 100:60:80 kg for potato, 120:60:60 kg for mustard and 100:60:40 kg ha-1 for linseed in both sole and intercrops. In case of intercropping, the fertilizer dose was adjusted for proportionate area of the intercrops. Greengram variety 'Samrat' were sown on 26 and 25 March during 2014 and 2015, respectively at same layout on previously cultivated winter crops and on residual INM practices.. The recommended seed rates of 20 kg/ha for greengram was used. Crop was irrigated as and when required. The other recommended agronomic practices were adopted to harvest the good yield.

RESULTS AND DISCUSSION

Growth Attributes

It is evident from the results revealed that the residual effect of cropping systems was found significant for growth attributes of greengram during both the years and on mean basis. The highest values of growth parameters, viz., dry matter accumulation/plant, branches/plant, number of nodules and nodule dry weight/plant of greengram were recorded at the previously grown potato, followed by linseed crop, which was significantly more than that of all maize-based intercropping systems. Similarly in intercropping treatments, maize + potato and maize + linseed grown plots proved superior to the maize + mustard grown plots in respect of growth attributes (Table 1.0).

Greengram plants accumulated maximum dry weight of 15.34 g and 15.62 g when grown after potato followed by when grown after linseed, among the intercropping system maize + potato recorded highest value (14.41 and 14.85 g) followed by maize + linseed (14.26 and 14.62g) during both seasons. The minimum dry matter (13.60 and 14.15 g) accumulated by greengram plants was recorded when grown after sole cropping of winter maize during both the years and on mean basis.

Greengram had more number of branches/plant of (4.33 and 4.39) when grown after sole cropping of potato, followed by when grown after sole linseed (4.28 and 4.36) during 2013-14 and 2014-2015, respectively, whereas in intercropping maize + potato (4.15 and 4.25) and maize + linseed (4.06 and 4.19) recorded highest value. The minimum branches/plant (3.93 and 4.06) was recorded when greengram cultivated after sole cropping of winter maize during both the years and on mean basis.

Number of nodules and nodule dry weight/plant of greengram were influenced significantly by cropping systems during both the years. Number and dry weight of nodules/plant was maximum when grown after sole potato and maize + potato intercropping system followed by when grown after sole linseed and maize + linseed intercropping system during both the years and on mean basis. Greengram when grown after sole winter maize recorded minimum number of nodules/plant and nodule dry weight/plant during both the years and on mean basis.

Table 1. Residual effect of cropping systems and integrated nitrogen management practices on growth parameters of succeeding greengram

Treatment	Dry matter accumulation at harvest (g/plant)			Branches/ plant			Number of nodules/ plant			Dry weight of nodules/ plant		
	2013-14	*2014-15*	*Mean*	*2013-14*	*2014-15*	*Mean*	*2013-14*	*2014-15*	*Mean*	*2013-14*	*2014-15*	*Mean*
Cropping Systems												
Sole Maize	13.60	14.15	13.88	3.93	4.06	4.00	15.47	16.12	15.79	6.12	6.45	6.29
Sole Potato	15.34	15.62	15.48	4.33	4.39	4.36	16.56	17.18	16.88	6.76	7.39	7.08
Sole Mustard	14.59	15.04	14.82	4.22	4.29	4.26	16.29	16.80	16.55	6.48	7.05	6.77
Sole Linseed	15.01	15.36	15.19	4.28	4.36	4.32	16.38	16.98	16.69	6.65	7.18	6.92
Maize + Potato (3:1)	14.41	14.85	14.63	4.15	4.25	4.20	16.14	16.70	16.42	6.38	6.93	6.66

Maize + Mustard (3:1)	13.98	14.49	14.24	4.01	4.12	4.07	15.71	16.43	16.07	6.25	6.53	6.39
Maize + Linseed (3:3)	14.26	14.62	14.44	4.06	4.19	4.12	15.93	16.59	16.26	6.35	6.77	6.56
SEd±	0.21	0.24	0.13	0.03	0.04	0.03	0.09	0.10	0.08	0.07	0.06	0.04
CD (P=0.05)	0.46	0.51	0.29	0.07	0.08	0.06	0.21	0.22	0.18	0.16	0.15	0.10
INM Protocols												
100% + 0% RDN	13.96	14.44	14.20	3.88	3.94	3.91	14.71	15.26	14.99	6.12	6.35	6.24
75% + 25% RDN	14.48	14.99	14.74	4.17	4.25	4.21	15.81	16.52	16.17	6.37	6.97	6.67
50% + 50% RDN	14.92	15.20	15.06	4.36	4.52	4.44	17.69	18.28	17.99	6.79	7.37	7.08
SEd±	0.19	0.16	0.11	0.02	0.03	0.02	0.08	0.08	0.07	0.05	0.05	0.04
CD (P=0.05)	0.42	0.37	0.24	0.05	0.05	0.04	0.18	0.017	0.016	0.13	0.12	0.10

Growth of greengram was markedly influenced by organic matter substitution in the preceding winter crops. The plot which received 50% N substitution through organics had the best expression. This treatment, however, also differed significantly with the treatments involving inorganic fertilizers (75%) substituted 25% N by organics. Further, both the INM treatments varied significantly and had higher values of growth parameters viz., dry matter accumulation/plant, branches/plant, number of nodules and nodule dry weight/plant compared to plots receiving 100% N through inorganic to winter crops. Residual effect of these INM protocols (75% + 25% RDN and 50% + 50% RDN) increased the dry matter accumulation/plant, branches/plant, number as well as weight of nodules/plant by average of 3.82 and 6.06%, 7.67 and 13.55%, 7.87 and 20.01, and 6.89 and 13.46% over previously fertilized plots with 100% N through inorganics, respectively (Table 1.0). The increase in growth attributes of greengram was owing to increased in nutrient availability through organics, as it releases major and minor nutrients slowly during entire growing season. Effectiveness of organic sources, in general, is manifested in the fact that organic matters release nutrients after mineralization which improves the physical and physic-chemical properties of soil (Yawalkar *et al.,* 1992).

Yield attributes and yield

Yield attributing characters of greengram viz., pods/plant, grains/pod, grain weight/pod, grain weight/ plant and 1000-grain weight influenced significantly due to various cropping systems. Among the sole cropping, sole potato had higher values (12.96 and 13.90, 6.26 and 7.05, 0.389 and 0.424g, 4.77 and 5.06g, 37.73 and 39.20 g respectively) of yield attributing characters of greengram, followed by sole linseed during both the years and on mean basis. In case of intercropping systems, greengram grown after maize + potato intercropping association had maximum values (12.64 and 13.72, 6.07 and 6.67, 0.369 and 0.403 g and 4.61 and 4.79 g, 35.89 and 36.87 g respectively) of all yield attributing characters, followed by greengram grown after maize + linseed system during both the years and on mean basis. Overall, minimum values of all yield attributing characters viz., pods/plant, grains/pod, grain weight/pod, grain weight/plant and 1000-grain weight (12.35 and 13.52, 5.77 and 6.36, 0.351 and 0.379g, 4.44 and 4.58g, 32.31 and 33.86 g respectively) of greengram was recorded when greengram grown after sole maize during both the years and on mean basis. (Table 2.0& 3.0).

Organic matters applied to the preceding winter crops had carry-over effect on greengram which resulted in better expression of yield attributes in plants raised in plots which had experienced substitution of nutrients through organic sources in the preceding crop(s). The highest values for all the yield attributing characters of subsequent greengram crop were recorded from the treatment receiving 50% N through inorganic and 50% N through organics in the preceding crops. The treatment which got 75% recommended dose of N through inorganics and the balance 25% N substituted through FYM and vermicompost in the equal proportion in the preceding crops also had higher values for all the yield attributes than the treatments receiving 100% N through inorganics in preceding crops (Table 2.0 & 3.0).

Table 2. Residual effect of cropping systems and integrated nitrogen management practices on yield attributes of succeeding greengram

Treatment	**Pods/ plant**			**Grains/ pod**			**Grain weight/ pod (g)**			**Grain weight/ plant (g)**		
	2013-14	***2014-15***	***Mean***	***2013-14***	***2014-15***	***Mean***	***2013-14***	***2014-15***	***Mean***	***2013-14***	***2014-15***	***Mean***
Cropping Systems												
Sole Maize	12.35	13.52	12.94	5.77	6.36	6.07	0.351	0.379	0.365	4.44	4.58	4.51
Sole Potato	12.96	13.90	13.43	6.26	7.05	6.65	0.389	0.424	0.407	4.77	5.06	4.84
Sole Mustard	12.73	13.77	13.25	6.13	6.87	6.50	0.374	0.410	0.392	4.65	4.86	4.76
Sole Linseed	12.79	13.84	13.32	6.20	6.98	6.59	0.382	0.414	0.398	4.70	4.96	4.83
Maize + Potato (3:1)	12.64	13.72	13.18	6.07	6.67	6.37	0.369	0.403	0.386	4.61	4.79	4.70
Maize + Mustard (3:1)	12.50	13.57	13.04	5.85	6.54	6.19	0.360	0.388	0.374	4.50	4.64	4.57
Maize + Linseed (3:3)	12.51	13.63	13.07	5.97	6.60	6.29	0.365	0.395	0.380	4.55	4.69	4.62
SEd±	0.13	0.10	0.09	0.04	0.04	0.03	0.011	0.009	0.007	0.05	0.04	0.03
CD (P=0.05)	0.29	0.24	0.20	0.09	0.08	0.07	0.024	0.20	0.015	0.11	0.09	0.07
INM Protocols	12.53	13.52	13.03	5.90	6.52	6.21	0.356	0.383	0.370	4.47	4.60	4.54

100% + 0% RDN	12.64	13.70	13.17	6.06	6.73	6.40	0.371	0.404	0.388	4.64	4.81	4.73
75% + 25% RDN	12.74	13.91	13.33	6.16	6.91	6.54	0.382	0.420	0.401	4.72	4.99	4.86
50% + 50% RDN	0.07	0.09	0.06	0.03	0.04	0.03	0.005	0.004	0.003	0.04	0.04	0.03
SEd±	0.17	0.20	0.13	0.07	0.10	0.06	0.009	0.009	0.006	0.08	0.09	0.06
CD (P=0.05)	12.35	13.52	12.94	5.77	6.36	6.07	0.351	0.379	0.365	4.44	4.58	4.51

Greengram yields varied significantly amongst different previously grown crops. Previously grown potato crop recorded the maximum yields in terms of grain and straw yield of greengram and was significantly superior to plots with sole maize and all the maize-based intercropping associations adopted in preceding season. While, treatments grown with linseed and mustard remained comparable to previously grown maize + potato in respect to greengram yields. This was due to probably overall nature of previously adopted winter crops which resulted variation in production potential of succeeding greengram crop (Table 3.0).

Grain yield was maximized under the treatments when greengram grown after sole potato, followed grown after sole linseed during both the years and on mean basis. Likewise, maize + potato intercropping system established its superiority under intercropping group and recorded on an average 1.68 and 2.14% higher grain yield of greengram over grown after maize + linseed and maize + mustard, respectively. Greengram grown after sole winter maize in succession recorded minimum grain yield during both the years and on mean basis.

It is obvious from the data revealed that greengram grown after sole cropping of potato recorded significantly higher straw yield during both the years and on mean basis. Greengram grown after sole linseed ranked on second place in respect of straw yield of greengram during 2013-14 and 2014-15 as well as on mean basis. Similar to the grain yield, straw yield also behaved in an akin fashion under intercropping group during both the seasons. Greengram grown after sole maize recorded minimum straw yield during both the years and on mean basis.

Table 3. Residual effect of cropping systems and integrated nitrogen management practices on yield of succeeding greengram

Treatment	1000-grain weight (g)			Grain yield (kg/ha)			Straw yield (kg/ha)			Harvest index (%)		
	2013-14	*2014-15*	*Mean*	*2013-14*	*2014-15*	*Mean*	*2013-14*	*2014-15*	*Mean*	*2013-14*	*2014-15*	*Mean*
Cropping Systems												
Sole Maize	32.31	33.86	33.09	826	913	870	1223	1386	1304	40.34	39.72	40.03
Sole Potato	37.73	39.20	38.47	869	998	934	1324	1509	1417	39.61	39.72	39.67
Sole Mustard	36.32	37.86	37.10	855	968	912	1281	1458	1370	40.02	39.86	39.94
Sole Linseed	36.84	38.54	37.70	864	982	923	1296	1500	1398	39.99	39.59	39.79
Maize + Potato (3:1)	35.89	36.87	36.38	851	960	906	1263	1451	1359	40.27	39.80	40.04
Maize + Mustard (3:1)	34.11	34.78	34.45	838	935	887	1232	1366	1299	40.49	40.61	40.56
Maize + Linseed (3:3)	35.11	36.09	35.60	840	941	891	1241	1411	1326	40.40	38.60	39.51
SEd±	1.01	0.97	0.84	0.004	0.004	0.003	0.021	0.019	0.016	0.23	0.22	0.17
CD (P=0.05)	2.22	1.99	1.72	0.010	0.009	0.007	0.044	0.041	0.036	0.51	0.46	0.37
INM Protocols												
100% + 0% RDN	34.70	35.94	35.32	801	874	838	1182	1332	1074	40.41	39.65	40.03
75% + 25% RDN	35.48	36.78	36.13	850	948	899	1286	1437	1362	39.80	39.13	39.47
50% + 50% RDN	36.24	37.51	36.88	896	1048	973	1329	1552	1441	40.28	40.32	40.30
SEd±	0.95	0.83	0.75	0.003	0.003	0.002	0.019	0.017	0.014	0.17	0.16	0.11
CD (P=0.05)	1.96	1.70	1.65	0.007	0.006	0.005	0.040	0.037	0.031	0.36	0.35	0.23

Residual of effect of INM protocols also influenced significantly on straw yield of greengram during both the years and on mean basis. Application of 50% + 50% RDN recorded significantly higher grain yield of greengram on residual fertility, which resulted in 8.23 and 16.12% higher over 75% + 25% RDN and 100% RDN alone, respectively.

On an average, application of 50% + 50% RDN to winter crops recorded significantly higher straw yield of greengram over rest of the INM protocols during both the seasons. Greengram grown on residual fertility of 100% RDN alone to winter crops registered the lowest grain and straw yield during both the years and on mean basis.

The organic matter applied in different proportions to winter crops significantly enhanced mean grain and straw yield of greengram to the extent of overall 11.69 and 30.49%, respectively over no organic treatment (Table 3.0). Higher yields of greengram was owing to better yield attributing characters viz., pods/plant, pod weight/plant, grains/pod, grain weight/pod, grain weight/ plant and 1000-grain weight as a result of improvement in soil physical, chemical and biological properties with organics. Secondly, after maize/ winter crops, the treatments having organic manures (FYM and vermicompost) might have left more nutrients in the soil than inorganic fertilizer plots, which was available for greengram crop. The results conform, Kumar (2008) and Naresh *et al*. (2013).

Based on above study suggested that greengram grown after sole potao and maize+potao intercropping system with 50% organic+50%

inorganic nitrogen management practice give higher yield under irrigated condition.

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