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Residual Effect of Wheat Varieties and Integrated Nutrient Management on Productivity and Profitability of Green Gram under North Gujarat Agro-climatic Condition

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ABSTRACT

Background: A field experiment was conducted during two consecutive *summer* seasons of 2016-17 and 2017-18 at Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat to assess the residual effect of wheat varieties and integrated nutrient management on growth, yield, economics and quality of green gram (*Vigna radiata* L.). The soil of the experimental plot was loamy sand in texture, low in organic carbon (0.24%), available nitrogen (159 kg/ha) and Zn (0.41 mg/kg), medium in available phosphorus (38.90 kg/ha) and high in available potash (287 kg/ha).

Methods: During the period 2016-17 to 2017-18 the experiment was laid out in a Factorial RBD with three replications, consisted of four varieties GW 273 (V_1), GW 322 (V_2), GW 451 (V_3) and GW 496 (V_4) and six integrated nutrient management control (N_1), 100% RDF (N_2), 100% RDF + *Azotobacter* + PSB (N_3), 75% RDF + *Azotobacter* + PSB (N_4), 75% RDF + *Azotobacter* + PSB + $ZnSO_4$ (N_5) and 50% RDF + 25% N through FYM + *Azotobacter* + PSB + $ZnSO_4$ (N_6).

Result: The pooled results indicated that among the residual effect of nutrient management practices, application of 50% RDF (RDF; 120:60:00 kg NPK/ha) + 25% N through FYM + *Azotobacter* + PSB + $ZnSO_4$ significantly improved growth parameters, yield attributes, seed yield (669 kg/ha) and stover yield (1406 kg/ha) over control and gained the highest net return (`18538/ha) and benefit: cost ratio of 0.88.

Key words: Growth parameters, Integrated nutrient management, Nutrient content and uptake, Wheat varieties, Yield, Yield attributes.

INTRODUCTION

Green gram (*Vigna radiata* L.) is one of the important pulse crops in India. Total annual production of greengram in India is 98.51 million tonnes with the productivity of 3.20 tonnes per hectare during 2017-18 (Anonymous 2017-18). The important green gram growing states in the country are Orissa, Maharashtra andhra Pradesh, Madhya Pradesh, Gujarat, Rajasthan and Bihar. Green gram contains about 25% protein, which is almost two times that of cereals. It is consumed in the form of split pulse as well as whole pulse, which is an essential supplement in cereal based diet. The Green gram Khichdi is recommended to the ill or aged person as it is easily digestible and considered as complete diet. Roti with green gram dal and green gram dal chawal is an important ingredient in the average Indian diet. The biological value improves greatly, when wheat or rice is combined with green gram because of the complementary relationship of the essential amino acids. It is particularly rich in leucine, phenylalanine, lysine, valine, isoleucine etc. In addition to being an important source of human food and animal feed, green gram also plays an important role in sustaining soil fertility by improving soil physical properties and fixing atmospheric nitrogen. It is a drought resistant crop and suitable for dryland farming. Green gram in contrast with green manures, provide grain to augment income and protein as well as reduce the use of mineral nitrogen in wheat-based cropping systems. In areas, where clear cut fallow of a short duration is available succeeding the wheat crop, crop like green gram can be raised as succeeding crop to wheat.

Hence, for long term agricultural sustainability, optimization of the crop nutrition through integrated use of all available nutrient sources is a must. Integrated nutrient management involves the conjunctive use of chemical fertilizers, organic manures, bio-fertilizers *etc*. and assumes greater importance due to decreasing soil health and fertility as well as reduced factor productivity (Prasad, 1999). According to prevailing circumstances, integrated nutrient management practice is perceived as a feasible option to restore soil health and fertility and get sustained higher crop

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yields. Organic manures, when applied in conjunction with mineral nutrients, not only improve the yield levels but also improves the soil health through their favourable effects on the physical, chemical and biological properties of the soil and thus, help sustain the productivity (Lourduraj, 1999). Use of organic manure supplies primary, secondary and micro-nutrients and helps in avoiding the deficiencies of these nutrients, which in recent year have become the key factor in reducing the response of crops to NPK applied through fertilizers only. Organic manures also have a pronounced residual effect on the soil fertility (Kumari and Singaram, 1996). Biofertilizers are the source of microbial inoculants, which have brought hopes for many countries both economically and environmentally. In developing countries like India, biofertilizers can solve problems of high cost of fertilizers and thus can save the economy of the country (Gupta *et al.* 2003). Bio-fertilisation is receiving steadily increased attention and recognition because biofertilizers are not only inexpensive but eco-friendly (Mahdi, 1993).

Therefore, the present investigation was carried out to study the effect of integrated nutrient management on wheat crop yield and nutrient status of soil after experimentation. It is hypothesised that integrated nutrient management would improve yield and soil nutrient status.

MATERIALS AND METHODS

Experimental site and weather

The experiment was conducted at Agronomy Instructional Farm, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar (24°-19' N latitude and 72°-19' E longitude with an elevation of 154.52 m above mean sea level) during the *summer* seasons of years 2016-17 and 2017-18. The mean maximum and minimum temperature was 36.4 and 36.8°C as well as 22.2 and 20.6°C during the growing seasons of both the years, respectively.

The soil at the experimental site was loamy sand of Typic Ustipsamments (sand 84%, silt 7.55%, clay 7.09%), neutral reaction (pH 7.4) with EC of 0.14 dS/m, low in organic carbon (0.24%) and available N (159 kg/ha), medium in available P_2O_5 (38.9 kg/ha) and available K_2O (287 kg/ha) and low in Zn (0.41 mg/kg).The details of physico-chemical properties of experimental soil are given in Table 1.

Experimental design and field management

The experiment was conducted to find out the residual effect of wheat varieties and integrated nutrient management on greengram crop yield. Treatments were laid out in factorial randomized block design with three replications. First factor included four wheat cultivars *viz.,* GW 273 (V_1), GW 322 (V_2), GW 451(V_3) and GW 496(V_4) and second factor comprised of six integrated nutrient management practices *viz.,* control (N_1), 100% RDF (N_2), 100% RDF + *Azotobacter*+ PSB (N_3), 75% RDF + *Azotobacter* + PSB (N_4), 75% RDF + *Azotobacter* + PSB + $ZnSO_4$ (N_5) and 50% RDF + 25% N through FYM + *Azotobacter*+ PSB + $ZnSO_4$ (N_6).

Crop was grown as per the recommended practices except the treatments under study. Field was prepared for sowing of crop and furrows were opened at 30 cm spacing with tractor. Four varieties of wheat *i.e.* GW 273, GW 322, GW 451 and GW 496 have been sown. No fertilizer application was made as per the treatments. Wheat cultivars on 17th and 14th November and harvested on 3rd and 1st March during 2016-17 and 2017-18, respectively. After one week sowing of green gram was done with the seed rate of 18 kg/ ha on 18th and 8th March and harvested on 23rd and 14th May during 2016-17 and 2017-18, respectively. Total four irrigations were given in greengram during entire season. Weeds were controlled by spraying pendimethalin (1.0 kg *a.i.*/ha) as pre-emergence followed by one interculturing and one hand weeding when required during crop season in both the years.

Sampling and measurement

Growth attributes

Plant height and number of branches per plant were recorded from five plants selected randomly and tagged permanently from each net plot. Height of individual plant was measured in cm at harvest from base of the plant to the top of the plant by using metre scale and the number of branches per plant was counted of the tagged plants. The data were averaged for both the observations.

Yield attributes and yield

Number of pods per plant was counted from theselected five plants in each net plot at harvest.After discarding border rows from each experimental plot, the crop was harvested and bundled. After proper sun drying for few days these were weighed to record biological yield. The produce was threshed and after proper cleaning it was weighed to record

Table 1: Physico-chemical properties of the soil of experimental field.

	Particular	Soil depth (0-15cm)
1. Mechanical composition		
i.	Coarse sand (%)	43.90
ii.	Fine sand (%)	40.10
iii.	Silt (%)	7.55
iv.	Clay (%)	7.09
v.	Textural class	Loamy sand
vi.	Taxonomy	*Typic ustipsamments*
2. Physical properties		
i.	Field capacity (%)	7.80
ii.	PWP (%)	3.70
iii.	Bulk density (Mgm^{-3})	1.44
3. Chemical properties		
i.	EC (1.2.5) (dSm^{-1})	0.14
ii.	Soil pH (1:2.5)	7.43
iii.	Available organic carbon (%)	0.24
iv.	Available nitrogen (kg/ha)	159.00
v.	Available P_2O_5 (kg/ha)	38.90
vi.	Available K_2O (kg/ha)	287.00
vii.	DTPA extractableZn (mg/kg)	0.41

the seed yield (kg/ha). Stover yield was calculated by subtracting seed yield from biological yield. The biological, seed and stover yields (including sample weight) recorded in kg/net plot was standardized to 8-10 per cent moisture and then weight was converted to per hectare by multiplying appropriate factor.

Protein content in seed

The seed samples were drawn from each net plot and subjected to chemical analysis. Nitrogen content of seed was determined by micro Kjeldahl digestion and distillation method (Jackson, 1973). Thereafter, the protein content (%) of seed was calculated by multiplying nitrogen content of the seed (%) with the factor 6.25 and was expressed as percentage on dry weight basis for each treatment.

Nutrient content

The seed and stover samples were collected at threshing from each plot were air dried and then ground to a fine powder for estimation of nitrogen, phosphorus and potassium concentration by standard methods given below.

Constituent	Method
Nitrogen (%)	Kjeldahl's method (Jackson, 1973)
Phosphorus (%)	Vanadomolybdo phosphoric yellow color method (Jackson, 1973)
Potassium (%)	Flame photometer method (Jackson, 1978)

Nutrient uptake

The total uptake of nitrogen, phosphorus and potassium in seed and stover were calculated by using following expression.

Nutrient uptake (kg/ha) =

[Nutrient content in seed (%) × Seed yield (kg/ha)]
+ [Nutrient Content in stover (%) × Stover yield (kg/ha)]

Available N, P, K, OC and Zn in soil

For estimation of available N, P, K, OC and Zn in soil, the samples were collected from 0-15 cm depth, dried, ground and passed through 0.2 mm sieve. Available N was estimated following (Subbaiah and Asija, 1956), available P as per (Olsen *et al.*,1954), available K as per (Hanway and Heidal, 1952), available Organic Carbon as per (Walkley and Black, 1934) and available Zn as per (Hanway and Heidal, 1952).

Net returns and benefit-cost ratio

In order to evaluate the effectiveness of different treatments and ascertain the most remunerative treatment, total expenses incurred on cultural operations from preparatory tillage to harvesting including additional treatment cost for each treatment were computed and subtracted from the respective gross income to workout net monetary returns/ ha gross income was computed taking prevailing market prices of the commodities. The B-C ratio was calculated for each treatment by dividing net return with cost of cultivation. The computation details of economics for each treatment are given in appendices at the end.

RESULTS AND DISCUSSION

Effect of wheat varieties

The results showed that the growth parameters, yield attributes, yield, nutrient content and uptake of greengram crop did not influence significantly due to residual effect of different wheat varieties.

Effect of integrated nutrient management

Growth parameters

The greengram crop was grown without fertilizer application and under the influence of different integrated nutrient management treatments, significant variation was observed on growth parameters. At harvest, significantly higher plant height (51.67 cm), maximum number of branches per plant (6.90) were observed under application of 50% RDF + 25% N through FYM + *Azotobacter* + PSB + $ZnSO_4$, the lower plant height and less number of branches per plant was recorded with the control (no fertilizer) treatment presented in Table 2.

The plant growth is the function of photosynthetic activity of the plants, translocation of photosynthates within the plant, which ultimately depend on their capacity to utilize available nutrients. This might be due to an adequate amount of nutrients supply that enhanced the cell division and cell enlargement and helped to convert more solar energy into chemical energy. Application of inorganic fertilizers with bio-fertilizers might have supplied the adequate and continuous amount of nutrients at different growth stages due to release of sufficient amount of nutrients by mineralization at a constant level that resulted in higher plant growth, which reflect as higher plant height of the crop. The increase in no. of branches per plant was attributed due to higher N uptake by the crop (Table 3). The beneficial effect of optimum and balanced fertilization involving organic with inorganic and bio fertilizers on number of branches per plant have also been investigated by (Jain *et al.,* 1995; Upadhyay *et al.,* 1999; Jat *et al.,* 2012; Patel *et al.,* 2013) with respect to plant height.

Yield attributes and yields

The residual effect due to integrated nutrient management treatment *i.e.* 50% RDF + 25% N through FYM + *Azotobacter* + PSB + $ZnSO_4$ recorded significantly the higher number of pods per plant (22.98), Test weight (38.72g), seed yield (669 kg/ha) and stover yield (1406 kg/ha). Significantly, the lower number of pods per plant, Test weight, seed yield and stover yields were recorded with nutrient management treatment control (no fertilizer) presented in Table 2.

This was largely attributed to better growth of plant which resulted in adequate supply of photosynthates for development of sink under higher level of integrated nutrient management. Positive response in terms of yield attributes to integrated nutrient management have also been reported by (Rajkhova *et al.,* 2002; Yakadri *et al*., 2002; Chaudhary *et al.,* 2003; Reddy *et al.,* 2011; Patel *et al.,* 2013).

The highest seed yield per hectare gained under these treatments might be due to chemical fertilizer in conjunction with organic and bio fertilizers that might have provided favourable soil environment and nourishment for better plant growth resulted in maximum seed yield per hectare. The higher yield in these treatments was due to cumulative effect of elevated growth stature as well as yield structure. Moreover, bio-fertilizers might have helped in increasing uptake of nutrients and conservation and availability of moisture to the plant. The increase in greengram seed yield with addition of inorganic and bio-fertilizers may be attributed to the fact that biofertilizer being the store house of nutrients that also release the applied nutrients at its optimum and improve the soil physical condition. This may be due to better synthesis of chlorophyll in leaves. This finding indicated that the combined application of well decomposed FYM with chemical fertilizers and bio-fertilizers was superior to sole inorganic fertilizer application. The results were supported by the findings of (Acharya and mondal *et al*., 2010; Ghanshyam *et al.,* 2010; Jat *et al*., 2012; Patel *et al.,* 2013).

Moreover, the application of chemical fertilizers along with bio-fertilizers and organic fertilizers has given residual effect on nutrient availability in the soil to the next crop; greengram utilized residual nitrogen as starter for their vegetative growth due to higher photosynthetic rates and chlorophyll contents of the plant. The increased availability of nutrients under these treatments might have improved the growth attributes that enhanced the photosynthesis and translocation of carbohydrates to sink site which ultimately led to positive increase in stover yield. The higher availability of nutrients might have increased its uptake which increased cell size and enhanced cell division, seems to have played an important role in increasing the plant height and yield. This finding confirms to those reported by (Reddy *et al.,* 2011; Jat *et al.,* 2012; Patel *et al.,* 2012; Patel *et al.,* 2013).

Quality parameter

The residual effect of all the integrated nutrient management treatments incorporated in preceding wheat crop on the succeeding greengram showed significant improvement in protein content as compared to control (N_1). The higher protein content (22.68%) were recorded under application of 50% RDF + 25% N through FYM+ *Azotobacter* + PSB + $ZnSO_4$ (N_6). Minimum protein content of 20.32% was noted with treatment N_1 (control) presented in Table 2.

It is an established fact that protein content is dependent on its growth and nutritional composition. Increase in seed protein content may be due to enhanced uptake and translocation of residual nitrates which was remain present in the soil due to the soil fixation and not used completely by previous crop. These nutrients utilized by succeeding greengram crop that provide nitrogen for amino acid synthesis. Increase in protein content might be due to increased N concentration in seed that is integral part of protein synthesis. Increased protein content might be due to adequate supply of nitrogen. Adequate supply of N is associated with the vigorous vegetative growth and dark green colour. Balanced and adequate supply of nitrogen in relation to other nutrients developed favourable conditions for the growth. The supply of nitrogen is related to the protein

Table 2: Residual effect of varieties and integrated nutrient management on plant stand, plant height, number of branches per plant, number of pods per plant, test weight, seed and stover yields, harvest index and protein content at harvest of greengram (Pooled data of two years).

Treatments	Plant stand (per metre row length)	Plant height (cm)	Number of branches/ plant	Number of pods/ plant	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest Index (%)	Protein content (%)
Varieties (V)									
V_1 : GW 273	8.82	48.87	6.42	21.78	37.54	643	1337	32.47	22.24
V_2 : GW 322	8.71	47.88	6.31	21.33	37.29	630	1332	32.11	22.04
V_3 : GW 451	8.58	46.53	6.09	21.09	37.11	605	1281	32.08	21.67
V_4 : GW 496	8.70	47.24	6.19	21.26	37.25	614	1294	32.18	21.84
S.Em±	0.17	0.81	0.10	0.35	0.68	10.52	21.79	0.66	0.20
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
Integrated nutrient management (N)									
N_1 : Control (No fertilizer)	8.49	42.78	5.48	19.42	35.47	568	1192	32.27	20.32
N_2 : 100% RDF	8.83	49.01	6.56	21.80	37.61	645	1365	32.09	22.19
N_3 : 100% RDF + *Azoto.* + PSB	8.95	50.46	6.87	22.58	38.27	657	1390	32.10	22.41
N_4 : 75% RDF + *Azoto.* + PSB	8.58	45.18	5.78	20.58	36.57	596	1279	31.79	22.03
N_5 : 75% RDF + *Azoto.* + PSB + $ZnSO_4$	8.68	46.66	5.95	20.85	37.15	603	1235	32.81	22.06
N_6 : 50% RDF + 25 % N through FYM+ *Azoto.* + PSB + $ZnSO_4$	8.68	51.67	6.90	22.98	38.72	669	1406	32.24	22.68
S. Em±	0.21	0.99	0.13	0.43	0.84	12.89	26.68	0.81	0.24
C. D. at 5%	NS	2.77	0.36	1.20	NS	36.19	74.94	NS	0.68
C. V.%	11.66	10.14	9.95	9.77	10.97	10.14	9.97	12.32	5.38

Table 3: Residual effect of varieties and integrated nutrient management on N, P and K content and nitrogen phosphorus and potassium uptake in greengram seed and stover (Pooled data of two years).

Treatments	Nutrient content in seed (%)			Nutrient content in stover (%)			Nutrient uptake in seed (%)			Nutrient uptake in stover (%)		
	N	P	K	N	P	K	N	P	K	N	P	K
Varieties (V)												
V_1 : GW 273	3.559	0.468	0.625	0.738	0.227	0.966	22.91	3.01	4.02	9.87	3.03	12.92
V_2 : GW 322	3.526	0.465	0.623	0.734	0.225	0.957	22.25	2.94	3.93	9.78	3.00	12.76
V_3 : GW 451	3.468	0.457	0.615	0.733	0.226	0.957	21.01	2.77	3.73	9.41	2.89	12.30
V_4 : GW 496	3.495	0.462	0.616	0.735	0.224	0.961	21.64	2.86	3.80	9.48	2.89	12.39
S.Em±	0.031	0.004	0.005	0.006	0.002	0.008	0.50	0.07	0.08	0.14	0.05	0.19
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Integrated nutrient management (N)												
N_1 : Control (No fertilizer)	3.252	0.440	0.587	0.702	0.213	0.898	18.46	2.50	3.33	8.36	2.54	10.70
N_2 : 100 % RDF	3.550	0.468	0.623	0.739	0.227	0.973	22.90	3.02	4.02	10.10	3.10	13.29
N_3 :100 % RDF + *Azoto.* + PSB	3.586	0.473	0.630	0.748	0.230	0.984	23.57	3.11	4.15	10.39	3.20	13.67
N_4 :75 % RDF + *Azoto.* + PSB	3.525	0.461	0.620	0.734	0.225	0.961	21.12	2.76	3.71	9.35	2.86	12.23
N_5 :75 % RDF + *Azoto.* + PSB + $ZnSO_4$	3.530	0.463	0.621	0.737	0.226	0.961	21.37	2.81	3.75	9.07	2.78	11.82
N_6 :50 % RDF + 25 % N through FYM+ *Azoto.* + PSB + $ZnSO_4$	3.629	0.473	0.635	0.751	0.231	0.985	24.30	3.17	4.25	10.55	3.24	13.83
S. Em±	0.039	0.005	0.006	0.007	0.003	0.010	0.61	0.08	0.10	0.18	0.06	0.23
C. D. at 5 %	0.108	0.014	0.016	0.019	0.007	0.027	1.72	0.23	0.29	0.50	0.16	0.66
C. V.%	5.38			4.52			13.69	13.60	12.96	9.00	9.22	9.14

formation. Further, it is seemed that organic manure improved physical, chemical and biological properties of the soil and this led to improved root growth and development, improved water and nutrient uptake resulting into improved seed quality in terms of higher seed protein content. Similar results found by (Chesti *et al.,* 2012; Jat *et al.,* 2012; Patel *et al.,* 2013).

Nutrients content in seed and stover

Thenutrients content (%) in seed and stover were significantly influenced by residual effect of different integrated nutrient management treatments. Maximum nitrogen, phosphorus and potassium content in seed 3.629%, 0.473%, 0.635% and in stover 0.751%, 0.231%, 0.985 % were noted under treatment N_6 *i.e.,* 50% RDF + 25% N through FYM+ *Azotobacter* + PSB + $ZnSO_4$ being statistically at par with N_3, N_2, N_5 and N_4 sequentially presented in Table 3.

Nutrients uptake in seed and stover

Thenutrients uptake (kg/ha) by seed and stover were significantly influenced by the residual effect of different treatments of integrated nutrient management. The higher values of nutrients uptake by seed 24.30, 3.17, 4.25 kg/ha and stover 10.55, 3.24, 13.83 kg/ha of N:P:K respectively were noted under treatment N_6(50% RDF + 25% N through FYM+ *Azotobacter* + PSB + $ZnSO_4$) but was statistically at par with N_3 (100% RDF + *Azotobacter*+ PSB) and N_2 (100% RDF/ha). The minimum uptake of NPK by seed 18.46, 2.50, 3.33 kg/ha and stover 8.36, 2.54, 10.70 kg/ha were observed with N_1 (control) presented in Table 3.

The higher removal of N and P with treatment N_6 might be due to better development of root and shoot of plants, that resulted in higher N and P uptake. These results are in accordance with those reported by (Ghanshyam *et al.,* 2010; Jat *et al.,* 2012; Patel *et al.,* 2013) with respect to N and P contents as well as their uptake.

Available N, P_2O_5 and K_2O in soil after harvest

The significant effect of integrated nutrient management on available N, P_2O_5 and K_2O was found in soil after harvest of greengram. The treatment N_3 (100% RDF + *Azotobacter*+ PSB) recorded significantly higher values of available N and P_2O_5 in soil after harvest, but it was statistically at par with the treatment N_2, N_4, N_5 and N_6 in case of available N and P_2O_5 in pooled analysis. The treatment N_1 control (No fertilizer) recorded significantly lower available N and P_2O_5. In case of available K_2O status the treatments showed non-significant effect in soil after harvest of greengram during both years as well as in pooled.

(Das *et al.,* 2009) revealed that integrated nutrient management improved the residual soil fertility after greengram to a greater extent and the gain in available organic carbon, nitrogen and P_2O_5 over the initial soil nutrient status. (Kacha *et al.,* 2008) observed that application of castor cake in chilli enhanced the available nitrogen status of the soil over no castor cake treatment. This might be due to higher quantity of organic manure along with bio-fertilizers *viz. Rhizobium* and PSB, which accumulated in soil resulting in build up of nutrients in the soil. Increase in available N might be due to the direct addition of N through organic manure and greater multiplication of soil microbes, which could convert organically bound N to inorganic form. Similar results have also been reported by (Gorade *et al.,* 2014).

Available Organic Carbon in soil after harvest

Among the treatments, conjunctive applications of organic and inorganic fertilizers in different combinations get influenced over treatment control in consideration of

Table 4: Residual effect of varieties and integrated nutrient management on available N, P_2O_5, K_2O, Organic Carbon and Zn status in soil after harvest of greengram (Pooled data of two years).

Treatments	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)	Organic Carbon(%)	Zn status (mg/kg)
Varieties (V)					
V_1 : GW 273	155.77	34.38	238.71	0.232	0.429
V_2 : GW 322	156.75	34.47	240.83	0.230	0.429
V_3 : GW 451	160.86	34.71	244.92	0.225	0.417
V_4 : GW 496	158.91	34.57	243.48	0.227	0.430
S.Em±	1.39	0.30	1.85	0.002	0.004
C. D. at 5%	NS	NS	NS	NS	NS
Integrated nutrient management (N)					
N_1 : Control (No fertilizer)	142.58	32.22	236.00	0.203	0.380
N_2 : 100 % RDF	161.51	35.17	243.98	0.209	0.431
N_3 :100 % RDF + *Azoto.* + PSB	164.37	35.57	245.04	0.235	0.435
N_4 :75 % RDF + *Azoto.* + PSB	158.44	34.65	241.21	0.217	0.394
N_5 :75 % RDF + *Azoto.* + PSB + $ZnSO_4$	158.93	34.72	242.41	0.239	0.454
N_6 :50 % RDF + 25 % N through FYM+ *Azoto.* + PSB + $ZnSO_4$	162.61	34.86	243.28	0.267	0.464
S. Em±	1.70	0.37	2.27	0.002	0.005
C. D. at 5%	4.76	1.04	NS	0.007	0.013
C. V.%	5.26	5.25	4.60	5.26	5.48

Table 5: Residual effect of varieties and integrated nutrient management on economics of green gram (Pooled data of two years).

Treatments	Seed yield (kg/ha)	Stover yield (kg/ha)	Cost (` /ha)	Gross return (` /ha)	Net return (` /ha)	B - C Ratio
Varieties (V)						
V_1 : GW 273	643	1337	21055	38012	16957	0.81
V_2 : GW 322	630	1332	21055	37314	16259	0.77
V_3 : GW 451	605	1281	21055	35819	14764	0.70
V_4 : GW 496	614	1294	21055	36349	15294	0.73
Integrated nutrient management (N)						
N_1 : Control (No fertilizer)	568	1192	21055	33596	12541	0.60
N_2 : 100 % RDF	645	1365	21055	38219	17164	0.82
N_3 : 100 % RDF + *Azotobacter*+ PSB	657	1390	21055	38902	17847	0.85
N_4 : 75 % RDF + *Azotobacter* + PSB	596	1279	21055	35324	14269	0.68
N_5 : 75 % RDF + *Azotobacter* + PSB + $ZnSO_4$	603	1235	21055	35607	14552	0.69
N_6 : 50 % RDF + 25 % N through FYM+ *Azotobacter*+ PSB + $ZnSO_4$	669	1406	21055	39593	18538	0.88

available organic carbon content in soil in presented Table 4. Significantly higher organic carbon content was recorded in soil under the treatment N_6 (50% RDF + 25% N through FYM + *Azotobacter* + PSB + $ZnSO_4$). However, significantly higher (0.267%) and the lowest (0.203%) values of available organic carbon in soil were recorded with the treatments N_6 (50% RDF + 25% N through organic manure + *Azotobacter* + PSB + $ZnSO_4$) and N_1 (control) in pooled analysis, respectively.

The organic carbon after harvest of the crop was observed under higher inputs (Integrated Nutrient Management), as these inputs resulted in higher vegetative growth of plants which implies that profuse root system has developed and thereby after harvest of crop more amount of root debris remained in the soil which converted in carbon source reflected in terms of higher organic carbon in soil. Increasing levels of NPK fertilization significantly increased the available N, P, K and Organic Carbon content in the soil (Kumari and Singaram, 1996).

Available zinc in soil after harvest

The application of 50% RDF + 25% N through FYM + *Azotobacter* + PSB + $ZnSO_4$ (N_6) and 75% RDF + *Azotobacter* + PSB + $ZnSO_4$ (N_5) recorded significantly higher content of available zinc in soil over rest of the treatments presented in Table 4. However, both these treatments were remained at par with each other. Application of treatments N_6 (50% RDF + 25% N through FYM + *Azotobacter* + PSB + $ZnSO_4$) registered significantly higher (0.464 mg/kg) and lower (0.380 mg/kg) content of available zinc in soil. Zinc exerts beneficial effect on N assimilation *via* its influence on nitrate reductase activity. Thus, N content in seed is significantly increased by following application of zinc. (Chaudhary *et al.,* 2014) were also observed the same trend of results in green gram.

Economics

Effect of varieties

The higher gross realization (` 38,012/ha), net realization (` 16,957/ha) and BCR (0.81) were secured by variety GW 273 (V_1) as compared to other varieties.

Effect of integrated nutrient management

Data on economics as influenced by different integrated nutrient management treatments are presented in Table 5. The higher gross realization (` 39,593/ha), net realization (` 18,538/ha) was incurred under the treatment N_6 (50% RDF + 25% N through FYM+ *Azotobacter* + PSB + $ZnSO_4$) with the BCR value of 0.88. The next better treatment in view of gross and net realization was N_3 (100% RDF+ *Azotobacter*+ PSB) which recorded the gross and net realization of ` 38,902/ha and ` 17,847/ha, respectively, with the BCR value of 0.85. The lowest gross realization ` 33,596, net realization of ` 12,541/ha and BCR value of 0.60 were found in N_1 (control). The results are in conformity with those reported by (Ambhore, 2004; Jat *et al.,* 2012; Patel *et al.,* 2013) with respect to higher net income and BCR.

CONCLUSION

Residual effect of treatments on growing succeeding green gram without fertilization after wheat *i.e.*, variety GW 273 grown with 50% RDF + 25% N through FYM + Azotobacter + PSB + $ZnSO_4$ secured higher green gram yield, net return and B:C ratio on loamy sand soil of North Gujarat.Sequence cropping of wheat (variety GW 451 with 100% RDF + Azotobacter + PSB) - green gram (without fertilization) produced higher net return and B:C ratio.

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