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YIELD, QUALITY PARAMETERS OF WHEAT (*TRITICUM AESTIVUM* L.) AND NUTRIENT STATUS OF SOIL AS INFLUENCED BY INTEGRATED NITROGEN MANAGEMENT AND THEIR RESIDUAL EFFECT ON SUCCEEDING FORAGE COWPEA (*VIGNA UNGUICULATA* L.)

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ABSTRACT

Application of 75% RDN + 25% RDN from FYM produced significantly higher grain yield and straw yield of wheat. Quality parameter of wheat were influenced by chemical treatments of N and soil status were influenced by combination of organic with chemical source of N. Seed inoculation with *Azotobacter chroococcum* + *Azospirillum lipoferum* maximize the yields of wheat. Combinations of 75% RDN + 25% from FYM with combination of bio-fertilizer produced higher quality parameters of wheat and 25% RDN + 25% from FYM + 25% from VC+25% from CC along with combination of bio-fertilizer improved nutrient status of soil in wheat-forage cowpea sequence in sandy loam soils under middle Gujarat Agro-climatic conditions.

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INTRODUCTION

Wheat *(Triticum aestivum L.)* is an important cereal crop of a large number of countries in the world and provides about 20% of total food calories for the human race (Hossain *et al.,* 2006).

In India, Gujarat ranks sixth in wheat production and the area under wheat crop. Gujarat is about 12.50 lakh hectares with total production of 29.07 lakh tones (Anon., 2011).

An adequate and optimum supply of nitrogen is required for vegetative growth and for maintaining genetical potential while, the deficit and excess reduce the production potential of crop (Singh *et al.*, 2006). The supplementary and complementary use of organic manures *viz.,* FYM, vermicompost, castor cake and inorganic fertilizers plays an important role in the growth and development of crop (Virmani, 1994). Non- symbiotic bacteria like *Azotobacter* and *Azospirilium* are potential bio-fertilizers capable of contributing nitrogen to a number of non-legume crops by trapping aerial reservoir (Ram and Mir, 2006). The integrated approach of nutrient supply by using organic, inorganic and bio-fertilizers is gaining importance, because this system not only reduces the use of costly inorganic fertilizers, but also it is an eco-friendly approach. (Sawarkar *et al.,* 2013). The application of organic manures may serve as excellent source of macro and micro nutrients (Kathuria *et al.*, 2005).

The package of practices so far generated on fodder cowpea is for getting maximum green and dry fodder production during lean period of the summer season, as animal husbandry has become a roaring business. Therefore, the study was undertaken in the present investigation as Yield, quality parameters of wheat (*Triticum aestivum* L.) and nutrient status of soil as influenced by integrated nitrogen management and their residual effect on succeeding forage cowpea (*Vigna unguiculata* L.).

MATERIALS AND METHODS

Experimental site

A field experiment was carried out at the College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand and Gujarat during *rabi* and *summer* seasons of the years 2011-12 and 2012-13 on Plot No. A-33 with succeeding forage cowpea taken after main crop of wheat on the same plot

Physico - chemical properties Soil

Composite soil samples were collected from the experimental site up to the depth of 0-15 cm and 15-30 cm before commencement of the experiment and were analyzed for the various physico-chemical properties. The soil of experimental site was sandy loam with 7.5 pH, organic carbon 0.38 %, EC 26 dsm^{-1}, available N 199.5 kg ha^{-1}, P_2O_5 32.17 kg ha^{-1} and high K_2O of 389.00 kg ha^{-1}. It is low to medium in Zn and Fe and sufficient in Mn and Cu. The soil was free from any kind of salinity or sodicity hazards. The experiment was laid out in Factorial Randomized

Block Design with three replication.

Varietal description

Wheat

The wheat variety GW-366 used in the present investigation was released by Wheat Research Station, Junagadh Agricultural University, Junagadh (Gujarat) during the year 2006. Variety is having medium maturity (116 -120 days). The distinguishing morphological features of GW-366 include pink auricle colour at flag leaf stage, curved panicle,medium ears, dense with glabours white glume, erect and medium leaves size and the grain size is bold with lustrous amber colour.

Cowpea: EC-4216

The variety EC-4216 is the most promising variety of fodder cowpea. It is mid duration variety, produces about 30 to 35 t ha^{-1} green fodder. It is mostly suitable for intercropping with various cereal forages and can grow well during *Kharif* and *summer* seasons. It is recommended for the Northern, Western and Central India.

Treatment details

Twenty one treatment combinations comprised of seven N management through chemical fertilizer and manures (F) *viz.*, F_1: 100 % RDN (from chemical fertilizer), F_2: 75 % RDN + 25 % RDN from FYM, F_3: 75 % RDN + 25 % RDN from Vermicomost, F_4: 75 % RDN + 25 % RDN from Castor cake, F_5: 50 % RDN + 25 % RDN from FYM + 25 % RDN from Vermicompost, F_6: 50 % RDN + 25 % RDN from FYM + 25 % RDN from Castor cake and F_7: 25 % RDN + 25 % RDN from FYM + 25 % RDN from Vermicompost + 25 % RDN from Castor cake and three levels of Bio-fertilizer inoculation (B) B_1: No bio-fertilizer inoculation, B_2: *Azotobacter chroococcum* inoculation, B_3: *Azotobacter chroococcum* + *Azospirillum lipoferum* inoculation. Recommended dose of P_2O_5 60 kg ha^{-1} in the form of Single Superphosphate was applied as basal at the time of sowing of wheat crop. No fertilizer was given to succeeding forage cowpea. Succeeding forage cowpea was taken in layout plots of wheat without disturbing the plat demarcations. Wheat crop was harvested during the month of March 2011-12 and 2012-13 years.

Grain yield and straw yield (kg ha^{-1})

The harvested crop of each net plot was sundried threshed and the grains were cleaned manually and weighed plot wise in kilogram. The plot wise straw yield was obtained by deducting the grain yield from the total produce (dry biomass) and recorded in kg $plot^{-1}$. The straw yield inclusive of stem, leave and husk per net plot was recorded plot wise and converted on hectare basis (kg ha^{-1}) by multiplying it with conversion factor. The weight of straw yield of earlier selected five plants taken for observations was also added in this yield.

Quality parameters

The chemical analysis of the oven dry samples straw as well as grain was carried out by digestion of 1 g of powdered sample with HNO_3: $HClO_4$ (2:1) diacid mixture as per the procedure outlined by Jackson (1973) and acid extracts were prepared. This acid extracts of the plant samples were used to analyse nitrogen content by following the standard analytical procedures. Nitrogen content of wheat grains was determined by Kjeldahl's method as suggested by Jackson (1973). Protein content of the grain was computed by multiplying the value of nitrogen content with conversion factor 6.25.

Soil nutrient status

Initial soil status soil

The initial soil samples drawn from 0-15 cm and 15-30 cm depth before experimentation. Samples were, grind and then sieved through 2 mm size sieve. The initial composite soil sample was analyzed for different physico-chemical properties

Nutrient content of the soil after harvest of the crop

The soil samples drawn after harvest of each crop from each plot during both the years were dried, grind and then sieved through 2 mm size sieve. The soil samples collected after harvest of the wheat crop from each treated plots for determination of soil status by standard methods of analysis.

RESULTS AND DISCUSSION

Effect of nitrogen management

Yields of wheat

Growth of the plant is important parameters for getting higher yield and quality production. In the present investigation, growth of plant was recorded at harvest of the crop. The data presented in Table 1 showed that the maximum higher grain yield 3,716 kg ha^{-1}) found under the treatment F_2 and it was superior to another treatments but, it was at par with F_1 and F_2 treatments on pooled analysis basis. The per cent increase in grain yield in the treatments F_2, F_1 and F_3 were 43.91, 38.57, respectively over the treatment F_7. Grain yield of wheat was observed higher under treatment F_2. Biswas and Reddy,2010 found that application of 75% N through chemical and 25% from FYM, as organics might have exerted favorable effect on the soil chemical, physical and bio logical properties resulting of better utilization of nutrients which in turn resulted in greater values of growth and yield parameters.

From the table, it is also cleared that treatment F_1 recorded significantly higher straw yield (7,771 kg ha^{-1}), was at par with treatment F_2 in pooled analysis it was probably due to higher level of nitrogen gave more vegetative growth resulting better utilization of nutrients, water, solar radiation and increased metabolic activity, which might have produced maximum dry matter production (Kulkarni et al., 2015 and Arun Kumar *et al.,* 2009).

Nutrient status of soil

Higher nitrogen content (1.79%), higher nitrogen content in the straw (0.96%) and protein content (11.21%) in wheat grains were recorded higher under the treatment F_1 (Yadav *et al.*, 2015). Rana and Singh, 2006 observed that that plant usually assimilate nitrogen ions in definite deficient population increase the availability of nutrient, usually result in better uptake of nutrients by plants, which have increased the nitrogen metabolism leading in to high nutrient content in the wheat grains and straw. The treatments F_5 and F_7 recorded the highest value of organic carbon, While treatment F_7 recorded significantly higher available soil nitrogen (283.05 N kg ha^{-1}) and the highest values of available phosphorus in the soil (63.33 kg ha^{-1}).

Table 1: Effect of INM and Bio-fertilizer levels on yields, quality parameters and nutrient status of soil after harvest of wheat. (Pooled value of 2 years)

Treatment	Yields (kg ha^{-1})		Quality parameters (%)			Nutrient status of soil (Kg ha^{-1})			
	Grain	Straw	Nitrogen content in the grains	Nitrogen content in the straw	Protein content	Organic carbon (%)	Available N	Available K_2O	Available P_2O_5
Nitrogen management (F)									
F_1:	3578	7771	1.79	0.96	11.21	0.47	257.3	52.60	179.2
F_2:	3716	7610	1.77	0.93	11.08	0.54	274.8	54.79	191.5
F_3:	3568	7133	1.77	0.92	11.05	0.51	273.1	55.59	228.6
F_4:	3378	6742	1.76	0.91	10.98	0.47	269.3	56.69	231.8
F_5:	2723	6534	1.73	0.91	10.80	0.59	276.6	57.61	235.1
F_6:	2582	6567	1.71	0.88	10.66	0.55	278.9	60.11	241.5
F_7:	2624	5514	1.67	0.85	10.44	0.59	283.0	63.33	255.4
S.Em. ±	71	226	0.02	0.01	0.12	0.01	1.96	0.50	18.72
C.D. (P=0.05)	200	783	0.05	0.04	0.33	0.02	5.52	1.40	NS
Bio-fertilizer inoculation (B)									
B_1:	3031	6551	1.72	0.90	10.73	0.53	268.7	56.46	218.4
B_2:	3142	6953	1.74	0.91	10.90	0.53	272.9	56.37	224.1
B_3:	3328	7013	1.77	0.92	11.04	0.53	278.2	58.90	227.4
S.Em. ±	47	86	0.01	0.01	0.08	0.00	1.28	0.75	0.91
C.D. (P=0.05)	131	243	0.03	NS	0.22	NS	3.61	NS	2.57
F x B	NS	NS	NS	Sig.	Sig.	Sig.	Sig.	Sig.	NS
CV (%)	9.52	8.19	4.61	6.10	4.61	4.85	3.04	3.67	2.65

Table 2: Interaction effect of INM and Bio-fertilizer levels on quality parameters and nutrient status of soil after harvest of wheat crop (Pooled value of 2 years)

Nitrogen management (F)	Bio-fertilizer inoculation (B)														
	B_1	B_2	B_3	B_1	B_2	B_3	B_1	B_2	B_3	B_1	B_2	B_3	B_1	B_2	B_3
	Nitrogen content in straw (%)			Protein content in grain (%)			Organic carbon (%)			Available N (kg ha^{-1})			Available P_2O_5 (kg ha^{-1})		
F_1:	0.92	0.97	0.98	11.14	11.26	11.24	0.48	0.46	0.46	256.9	259.6	255.4	50.98	51.46	55.36
F_2:	0.98	0.89	0.94	10.67	11.28	11.30	0.51	0.54	0.56	275.1	274.6	274.7	53.02	55.41	55.95
F_3:	0.93	0.92	0.93	10.91	10.94	11.31	0.53	0.51	0.48	266.7	275.9	276.7	53.70	56.12	56.96
F_4:	0.92	0.92	0.90	11.10	11.06	10.77	0.47	0.46	0.49	256.7	263.9	287.2	57.01	53.70	59.36
F_5:	0.92	0.95	0.85	10.17	10.71	11.53	0.59	0.59	0.59	271.5	275.5	282.9	57.29	56.43	59.10
F_6:	0.82	0.87	0.96	10.78	10.49	10.72	0.55	0.54	0.57	274.8	279.5	2825	60.25	59.36	60.71
F_7:	0.85	0.83	0.86	10.34	10.58	10.41	0.59	0.60	0.59	279.6	281.6	287.9	62.99	62.15	64.84
S.Em. ±	0.02			0.20			0.01			3.40			0.86		
C.D.(P=0.05)	0.06			0.58			0.03			9.56			2.42		

Available potassium in the soil after harvest of the wheat crop was did not alter significantly in the pooled result. Tolanur and Badanur, 2003 was observed that higher values of nutrient content in the soil after harvest of wheat crop observed it might be due to organic manures is slow process and it will take longer time to release the nutrients in the soil that's why such type of result was registered during both the years and pooled result.

Effect of bio-fertilizer

Yields of wheat

Significantly the highest grain yield (3,228 kg ha^{-1}) and higher straw yield (7,013 kg ha^{-1}) was noticed under seed inoculation with treatment B_3. The improvement in grain yield with treatment B_3 over B_1 was to the tune of 09.79 %. Treatment B_3 also registered significantly higher nitrogen content in wheat grain (1.77 %) under pooled result, but was at par with treatment B_2. The results in regards to nitrogen content in wheat straw due to bio-fertilizers inoculation treatments were found non-significant.

Quality parameters

The highest protein and nitrogen content was registered under similar treatment. Effect of bio-fertilizer inoculation on organic carbon content in the soil after harvest of the wheat crop was found non-significant.

Nutrient status of soil

The seed inoculation with *Azotobacter chroococcum* + *Azospirillum lipoferum* (B_3) registered significantly the highest value of available soil nitrogen and available potassium in the soil (280.4 and 277.40 kg ha^{-1}, respectively). Effect of bio-fertilizer inoculation on available phosphorus content in the soil was found non-significant.

Interaction effect

Data presented in Table 2 showed that combinations of organic,

Table 3: Residual effect of INM and Bio-fertilizer levels on yields and protein content of succeeding forage cowpea. (Pooled value of 2 years).

Treatment	Green fodder yield (q ha^{-1})	Dry fodder yield (q ha^{-1})	Crude protein content (%)
Nitrogen management (F)			
F_1:	204	49	13.06
F_2:	249	60	13.19
F_3:	235	57	13.40
F_4:	211	51	13.60
F_5:	259	62	13.76
F_6:	249	60	13.69
F_7:	275	66	14.05
S.Em. ±	12.81	3.09	0.12
C.D. (P=0.05)	NS	NS	0.33
Bio-fertilizer inoculation (B)			
B_1:	233	56	13.38
B_2:	238	57	13.52
B_3:	250	60	13.71
S.Em. ±	4.35	1.05	0.08
C.D. (P=0.05)	12.24	2.95	0.21
F x B	NS	NS	NS

inorganic fertilizer with bio-fertilizer that F_1B_3 and F_2B_1 recorded significantly higher nitrogen content in the straw than rest of the treatment combinations but, remained at par with treatment combinations F_1B_2, F_6B_3, F_5B_2, F_3B_1, F_3B_3, F_1B_1, F_3B_1, F_3B_2, F_4B_1 and F_4B_2. While, Treatment combination F_5B_3 recorded significantly higher protein content in the grains of wheat (11.53%) but, was found at par with treatment combinations F_3B_3, F_2B_3, F_2B_2, F_1B_3, F_1B_2, F_1B_1, F_4B_1 and F_4B_2. Vora *et al.,* 2010 observed that the maximum nitrogen and protein content from interaction of nitrogen management and bio-fertilizer inoculation may be due to enhanced absorption of available N in protein synthesis. The highest sugar was attributed to cumulative effect of adequate supply of nutrients and higher available N content which turn helped the formation and transfer of protein from roots to grains.

Soil status of the investigated soil recorded maximum organic carbon content under F_7B_2 combination than other treatment, except the treatment combinations F_5B_1, F_5B_2, F_5B_3, F_7B_2, F_7B_3 and F_6B_3. This increased in organic carbon was due to combined application of organic, inorganic and bio-fertilizer inoculation as source, which enhanced the decomposition of organic matter by increased microbial activities. The significantly higher available nitrogen content (287.91 kg ha^{-1}) and available phosphorus in the soil (64.84 kg ha^{-1}) in the soil were recorded under treatment combination F_7B_3 than rest of the treatment combinations

Residual effect on succeeding forage cowpea

In the present investigation, it has been found that Nitrogen management treatments was non-significant is found in green fodder yield and dry fodder yield of forage cowpea in pooled analysis. The treatment F_7 recorded significantly higher crude protein content (14.05) in pooled analysis (Table 3). Bio-fertilizer inoculation treatments have non-significant effect on green forage yield and dry matter yield of succeeding forage cowpea during individual years.

Higher yields obtained under treatment B_3 was due to fact that all the fixed-N in the wheat crop is are not much utilized by wheat crop. Significantly higher of crude protein content (13.71%) was recorded under treatment B_3 in pooled result. (Nag and Roy, 2008).

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