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Effect of integrated nutrient management for sustainable production system of maize (*Zea mays* L.) in indo-gangetic plain zone of India

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Abstract
To get more yield farmers tend to use excessive chemical fertilizers, while current energy crisis prevailing higher prices and lack of proper supply system of fertilizers and deterioration of soil health calls for more efficient nutrient management using conjunctive use of organic manure, inorganic fertilizers and biofertilizer to sustain yield levels and agro-eco-system. Therefore, a thrice replicated 2 year field trial was conducted during 2010 and 2011 by using F test. The results revealed that combination of 100% NPK + 5 t FYM+ Azotobacter + PSB recoded higher mean growth attributes *viz.*,plant height (201.25 cm), dry weight/plant (267.25 g), LAI at 60 DAS (4.2), yield attributing component and yield *viz.*, cob/plants (1.1), number of grain/cob (541.2) and test weight (245.05 g), grain yield (53.15 q/ha), quality parameters *viz.*, protein content (8.38%) and protein yield (445.4kg/ha), total nutrients uptake and economics *viz.*,net return/ha (Rs 36073.5), B:C ratio (2.86), production efficiency (59.1 kg/day/ha) and economic efficiency (400.8 Rs/day/ha), besides achieved maximum nitrogen used efficiency as compared to rest of its counterparts Thus, study suggests that maize can be successfully grown under Indo-Gangetic plain zone on 100% NPK + 5 t FYM+ Azotobacter + PSB and harvest maximum productivity and profitability besides, improving used efficiency of nitrogen.

Keywords: INM, Indo-Gangetic Plain Zone, Maize, NiUE and Sustainable Production System

1. Introduction

Utilization of indigenous sources of organics act as alternatives and/or supplements to chemical fertilizers and even help in increasing the productivity of the maize (Seshaiah, 2000) [17]. Worldwide maize is the top ranking cereal crop in potential grain productivity. By 2020 AD, the requirement of maize will be around 100 mt for various sector, of which the poultry sector alone demand 31 mt. It is a very difficult work for our researchers to increase the production of maize from the present level of 34 to 100 Mt (Seshaiah, 2000) [17].

Since inception of Green Revolution there has been a race for increasing cereal production by using synthetic chemical fertilizers in India. Over the years, India was able to increase food grain production by 5 times at the cost of Remarkable 322 times increase in fertilizer consumption staggering ‘net negative nutrient balance’ of 10 million tonnes has been reported in India which is anticipated to reach 15 million tonnes upto 2025. Considering high cost of fertilizers and their adverse implications on environmental due to their imbalanced use, fertilizer recommendations based on soil test values, residual effect and yield targets become highly important in India (Prasad, 2009) [15].

To get more yield farmers tend to use excessive chemical fertilizers, but decision on fertilizer use requires knowledge of the expected crop yield response to nutrient application, which is a function of crop nutrients need, supply of nutrients from soil as an indigenous source its inherent capacity to supply nutrients and the short and long term fate of fertilizer applied (Dobermann *et al*., 2003) [3].

The current energy crisis prevailing lack of proper supply system and higher prices of fertilizers, distortion of soil fertility and deterioration of soil health calls for more efficient nutrient management by using conjunctive use of organic manure and inorganic fertilizers to sustain yield levels. An effective nutrient management is the one which involves site specific nutrient recommendations to crops. This includes timely application of fertilizers using appropriate methods and developing and practicing integrated plant nutrient supply system using chemical fertilizers, organic manures, crop residues and biofertilizers and balanced fertilizer nutrient application (Satish *et al*., 2011) [16]. The treatments receiving both inorganic and organic fertilizers in *Kharif* season, followed by only inorganic fertilizers during summer season has improved the soil fertility, rice-maize grain and straw yield. The uptake pattern also followed the yield of both the crops. (Chandravanshi *et al.*, 2014) [1]. Though, RDF alone can be reduced up to 85% by supplying nutrients through organics. (Manasa *et al*., 2015) [10]. Moreover, the values of all nitrogen use efficiency (NiUE) in Western Uttar Pradesh were much lower as compared to the global level. (Naresh *et al*., 2014) [11]. Therefore, the present study was planned to evaluate performance, productivity and used efficiency of nitrogen as influenced by integrated nutrient management in maize.

2. Matarials and method

Experimental details and site description

A field trial was carried out for two consecutive years during *kharif* 2010 and 2011 at crop research centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (UP) satuated at a latitude of 29° 40' North and longitude of 77° 42' East with an elevation of 237 meters above sea level. The mean maximum as well as minimum temperature of 41^0 to 45^0 was recorded in the month of June and minimum touches as low as 16.6^0 in October. The mean annual rainfall during crop growing period was 807 mm (75-83% of which is received during July to September) and average relative humility varied between 67 to 85% throughout the both the years. The experimental trial was well drained, sandy loam in texture (46.2 % sand, 18.5 % silt and 17.3 % clay, hydrometer method) and slightly alkaline in reaction (pH 7.87, Glass electrode pH meter). It was medium in organic carbon available nitrogen and available phosphorus, whereas high in available potassium (0.576 and 0.578 %, 0.98 and 1.01 %, 224.8 and 226.2 kg/ha, 16.9 and 17.3 kg/ha and 250.4 and 249.0 kg/ha first and second years, respectively) with an electrical conductivity (1:2, soil: water suspension, Solbridge conductivity meter method) and Bulk density, Core sampler method of 1.61 dS/m and 1.41 Mg/m^3, respectively. All the soil properties were analyzed as per the standard procedures adopted by Jackson (1973) [6]. The experiment was laid out in randomized block design with three replication. The maize crop was grown as per agronomic package of practice with a varieties of Kanchan with the spacing (rows) of 50 cm. The seeds of crop were placed manually in the furrows at a plant to plant distance of 20 cm with a seed rate of 20 kg/ha and sown on 25 July during 2010 and 2011, while harvested on 23 October 2010 and 24 October 2011, respectively. The 100 per cent NPK is characterized by 120 kg N, 60 kg P_2O_5 and 40 kg K_2O/ ha and FYM is applied @ 5 t/ha as per the treatments whereas, PSB is used as seed treatment @ 20 g/kg of seed. Two hand weedings were performed manually with the help of Khurpi for controlling weeds, first at 25 DAS and second at 45 DAS. The maize is highly sensitive to water excess and stress, therefore surface drains were opened just after sowing to ensure proper drainage. Moreover, Only 1 irrigation was applied at 60 DAS due to rains commensurate well with crop water requirement at critical stages.

Data collection

Various growth parameters *viz.*, plant height (cm) and dry matter accumulation (g/plant) was recorded at maturity, leaf area index was calculated at 60 DAS and yield attributes were also measured at maturity stage. Grain yield was estimated by the obtained produce from net plot area, treatment wise and finally expressed at 14 % moisture from 15 m^2, whereas production and economic efficiency was calculated as per the standard procedure used by Kumawat *et al*., (2012) [9].

Plant sampling and analysis

The total uptake of N, P and K was determined by plants which were used for analyze the N, P and K content in plant. The plant samples were dried at 70 °C in a hot air oven. The dried samples were ground in a stainless steel Thomas Model 4 Wiley ® Mill. Further, the N content in plant was determined by digesting the plant samples in H_2SO_4, followed by analysis of total N by the Kjeldahl method (Page, 1982) [12] using a Kjeltec™ 8000 auto analyzer (FOSS Company, Denmark). Whereas, the P content in plant was resolute by the vanadomolybdo-phosphoric yellow colour method and the K content was determined in di-acid (HNO3 and HClO4) digests by the flame photometeric method (Page, 1982) [12]. The uptake of the nutrients (NPK) were calculated by multiplying the nutrient content (%) by their respective yield (kg/ha^{-1}) and then divided by 100 to get the uptake in kg/ha^{-1}. Finally the sum of grain and stover calculate total uptake.

Nitrogen use efficiency

The effectiveness of applied nitrogen is to be establish by this factor. The most important advantage of these index is that, it quantifies total economic output from any particular nutrient/, factor related to its utilization from all resources, including nutrients from applied inputs and native soil nutrients (Dobermann *et al*., 2002) [2]. The following expressions are used for determining nitrogen used efficiency:

1 Agronomic efficiency of applied nitrogen (AE_N)

AE_N = kg grain yield increase per kg N applied (often used synonym: N use efficiency:

$$AE_N = \Delta\, GY_{+N} / FN$$

Where,

GY_{+N} is the grain yield in a treatment with nitrogen application in kg ha^{-1}.

GY_{0N} is the grain yield in a treatment without nitrogen application, and FN is the amount of fertilizer nitrogen applied, all in kg ha^{-1}.

2 Recovery efficiency of applied nitrogen (RE_N)

RE_N = kg nitrogen taken up per kg nitrogen applied:

$$RE_N = UN_{+N} - UN_{0N}$$

Where,

UN_{+N} is the total nitrogen uptake measured in above ground biomass at physiological maturity (kg ha^{-1}) in a plots that received applied N at the rate of FN (kg ha^{-1}).

UN_{0N} is the total N uptake without N addition.

3 Partial factor productivity (PFP_N)

PFP_N = kg grain per kg nitrogen applied:

$$PFP_N = GY_{+N} / FN$$

Where,

GY_{+N} is the grain yield in kg ha^{-1} and

FN is the amount of fertilizer nitrogen applied in kg ha^{-1}.

4 Physiological efficiency of applied nitrogen (PE_N)

PE_N = kg grain yield increase per kg fertilizer nitrogen taken up:

$PE_N = (GY_{+N} – GY_{0N}) / (UN_{+N} – UN_{0N})$

Where,

GY_{+N} is the grain yield in a treatment with nitrogen application in kg ha^{-1}.
GY_{0N} is the grain yield in a treatment without nitrogen application in kg ha^{-1}.
UN_{+N} are the total N uptake in a treatment with nitrogen application in kg ha^{-1}.
UN_{0N} is the total N uptake in a treatment without nitrogen application in kg ha^{-1}.

Economic study

Benefit: cost ratio in terms of net return per rupee investment was calculated by using the following formula:

$$B : C = \frac{\text{Net return(Rs/ha)}}{\text{Cost of cultivation(Rs/ha)}}$$

Statistical analysis

The data obtained were subjected to analyze statistically as outlined by Gomez and Gomez (1984). The treatment differences were tested by using "F" test and critical differences (at 5 per cent probability).

3. Results and discussion

Growth attributes

Application of 100% NPK along with 5 t FYM+ Azotobacter + PSB produced significantly higher growth attributes *viz.*, plant height (203.6 and 198.9 cm) and dry matter accumulation (265.1 and 269.4 g) during 2010 and 2011, respectively (Table 1). Although plant height remained statistically on par with T_2 to T_6 and T_9 during both the year, while dry matter accumulation also clashes with all treatments, except control during both the year. However, the magnitude was higher in second year for dry matter accumulation and first year for plant height. Moreover, lowest growth attributes were measured in control plot during 2010 and 2011, respectively.The results so obtained in performances probably due to nutrients were responsible for increased cell division, cell enlargement, growth, photosynthesis, and protein synthesis which are responsible for quantitative increase in plant growth. The results of present study are in agreement with the findings of several other investigators (Panwar, 2008 and Manasa *et al*., 2015) [13, 10].

Leaf area index

Significantly maximum leaf area index (4.2) average pool of two year was noticed under 100% NPK + 5 t FYM+ Azotobacter + PSB which was superior to control during both year and 75% NPK alone during previous year while remained on par to all other treatments (Table 1). Application of FYM and biofertilizer were not brought any changes in leaf area index. Moreover, lowest leaf area index was measured in control plot during both the year. The higher values of LAI might be associated with increased availability of nitrogen and phosphorus due to using Azotobacter and PSB and having balanced nutrition which played an important role in rapid cell division and elongation in meristmatic plant tissues. Kumari *et al*. (2012) [8, 9] also reported more leaf area due to higher fertility and PSB inoculation.

Yield attributes

Treatments T_3 to T_6 and T_{10} recorded significantly similar and maximum cob/plant (1.1), while remaining other treatment also shown a similar values (1.0) including unfertilized plot (Table 1). Furthermore, number of grain per cob and test weight was seen higher under the treatments where FYM and both biofertilizer had to be used, however number of grain per cob remained on par to T_3 only, whereas test weight to T_3, T_4 and T_6 and significantly superior to rest of the level. Though, lowest yield attributes were measured in control plot during both the year.It might be due to better effect of inorganic and organic sources on the adequate nutrients supply for longer period, which will affects crop growth and photosynthetic activity. Similar results were found by Sharma *et al.* (2013) [18] and Kokani *et al*. (2014) [7].

Yields

Yields were also varied significantly due to increment of fertility level and reached to maximum in T_{10} (100% NPK + 5 t FYM+ Azotobacter + PSB) (Table 2). Maximum grain, stover and biological yield were recorded under 100% NPK + 5 t FYM+ Azotobacter + PSB which were 52.7 and 53.6 q/ha for grain, 75.6 and 73.6 q/ha for stover and 128.3 and 127.2 q/ha for biological yield, while stover yield were superior over rest of its counterparts. Moreover, application of 100% NPK + 5 t FYM were statistically on par to T_{10} for grain and biological yield during both the year, whereas, grain yield were also remained statistically on par to T_6 and T_9 and superior over rest of the treatments, as above unfertilized plot were also recorded lowest yield as compared to other treatments. Similar results were obtained by Kokani *et al*., (2014) [7] and Kumar *et al*. (2015) observed that incorporation of organic residues along with inorganic fertilizer significantly increased uptake of N, P and K by plants which facilitated the allocation and transfer of nutrient elements to the grains and straw.

Harvest index

Data depicted in Figure 1 revealed that application of 100% NPK + 5 t FYM+ Azotobacter + PSB recorded maximum harvest index as compared to other treatments, while 75% NPK recorded lowest harvest index but it was much higher from unfertilized plot. More control recorded lowest harvest index during both the year of experimentation. Similar results were found by Sharma *et al.* (2013) [18].

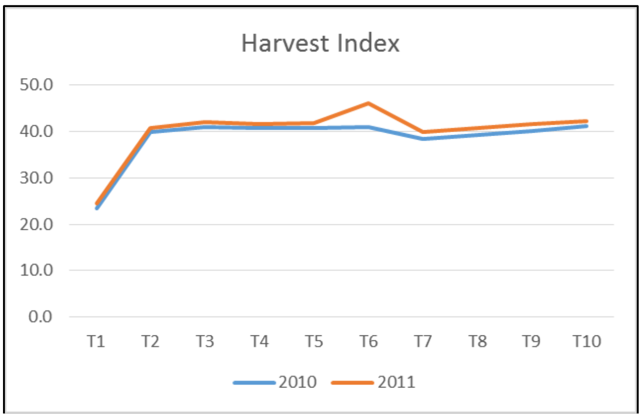

Fig 1: Effect of different treatments on harvest index

Nutrient Uptake

Significantly higher removal of NPK were noticed under 100% NPK + 5 t FYM+ Azotobacter + PSB which was superior to rest of its counterparts, except P uptake in 100% NPK + 5 t FYM. Although, the magnitudes of nutrient removal were higher in 2011 as against 2010 (Table 2). Moreover unfertilized plot removed least amount of Nitrogen (46.8 and 47.1 kg/ha), phosphorus (13.1 and 13.6 kg/ha) and potassium (71.1 and 71.6 kg/ha). Application of 75% NPK along with other parts were also shown lowest removal of NPK as against 100% NPK with either FYM or biofertilizer. Higher uptake of N P and K was may be due to favorable effect of incorporation of organic sources together with inorganic nutrients which was earlier reported by Sharma *et al*. (2013) [18]. Moreover, Decomposition of organic source is accompanied by the release of appreciable amount of Co2 which dissolve in water to form carbonic acid being capable of decomposition of certain primary minerals and release of nutrients, besides favors higher biomass production and nutrient uptake (Chandravanshi, 2014) [1]. Similar opinion was also put forward by Kumar *et al*. (2015).

Quality attributes

Significantly maximum protein content (8.35 and 8.41%) and protein yield (440.0 and 450.8 kg/ha) during 2010 and 2011, respectively were recorded under the treatments of 100% NPK + 5 t FYM+ Azotobacter + PSB (Table 3) which was superior to rest of its counterparts for protein yields, while it remained on par to protein content from T_3 to T_6. Moreover lowest protein content and protein yield were observed under the plot where no fertilizer was used. This may be ascribed to intense protein synthesis in plant and its efficient storage in the presence of abundant supply of available nutrients through biofertilizer and organics. The easy availability of nutrients leads to balanced C:N ratio which enhanced the vegetative growth of plant resulting in high photosynthetic activity. Which finally out yielded better protein content in plant and higher grain yield which in turn improved the protein yield. The results of present investigation corroborate with the findings of few previous studies (Pathak *et al*., 2002 and Sharma *et al*., 2013) [14, 18].

Production economics

Computation of valued revealed that maximum net return (35508 and 36639 Rs/ha), B:C ratio (2.83 and 2.89) during 2010 and 2011, respectively as against other of its treatments were fetched under the treatments where 100% NPK + 5 t FYM+ Azotobacter + PSB had applied (Table 3). This mainly due to maximum yield produced under this level which overcome the cost of FYM and biofertilizer and benefited more. Furthermore, production efficiency (58.6 and 59.6 kg/day/ha) and economic efficiency (394.5 and 407.1 Rs/day/ha) was also observed maximum under 100% NPK + 5 t FYM+ Azotobacter + PSB. Although lower production economics were recorded under control plots. These findings lend support to the report of Shete *et al*. (2011) [19] and Dwivedi *et al*. (2015) [4].

Nitrogen use efficiency (NIUE)

The values of all nitrogen use efficiency (NiUE) in India were lower as against global (Figure 2 and 3). Moreover, values of NIUE in the field experiment in western U. P. showed that, N is much more efficiently utilized in world as compared with western U. P. in India. Consequently, in western U. P., there is a considerable scope for increase efficiency of nitrogenous fertilizer (Naresh *et al*., 2014) [11]. For that, a computation of values present in Figure 1 revealed that the combination of organic, inorganic and biofertilizer (100% NPK + 5 t FYM+ Azotobacter + PSB) had got maximum average of two year nitrogen use efficiency viz., agronomic efficiency (32.7 kg/ha), partial factor productivity (44.29), recovery efficiency (72.5%) and physiological efficiency (37.6%). Moreover lower efficiency were recorded under control plot. This finding corroborates with the report by Naresh *et al*. (2014) [11] and Dwivedi *et al*. (2015) [4].

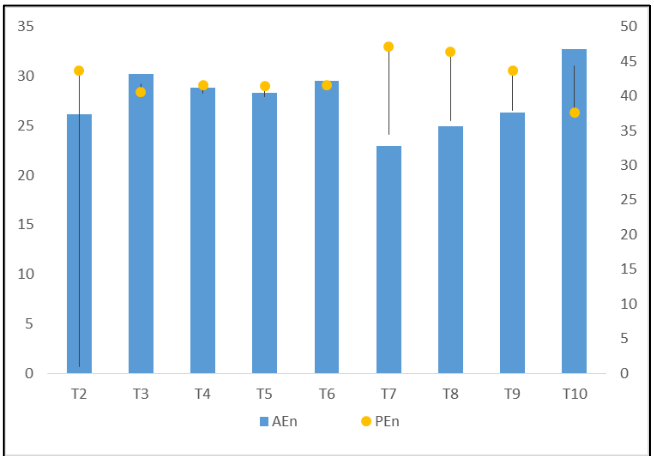

Fig 2: Effect of different treatments on agronomic efficiency and physiological efficiency

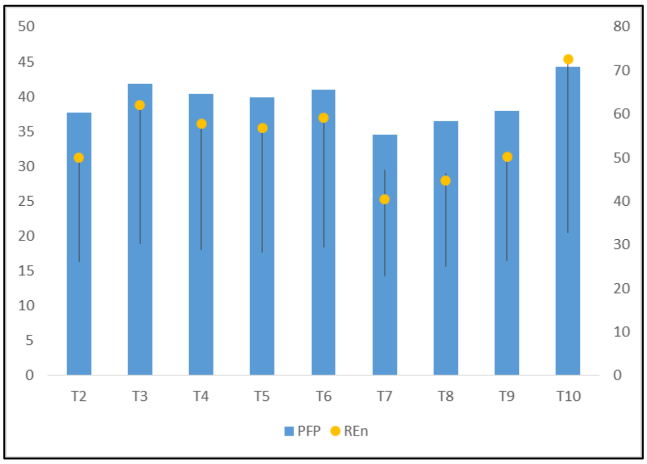

Fig 3: Effect of different treatments on partial factor productivity and recovery efficiency

Table 1: Effect of different treatments on growth, LAI and yield attributes

Treatments		Plant height (cm)		Leaf area index at 60 DAS		Dry matter production (g/plant)		Cob/plant		Number of grain/cob		Test weight (g)	
		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
T_1	Control	151.6	146.3	2.0	2.3	234.8	238.8	1.0	1.0	362.3	368.8	217.2	219.3
T_2	100% NPK	187.5	182.7	3.5	3.8	248.0	254.6	1.0	1.0	428.0	435.9	229.4	233.5
T_3	100% NPK + 5 t FYM	202.3	196.8	3.9	4.3	256.9	261.8	1.1	1.1	516.0	521.4	237.4	241.2
T_4	100% NPK + Azotobactor	200.7	193.1	3.7	3.9	253.6	259.5	1.1	1.1	488.3	495.2	236.5	239.3
T_5	100% NPK + PSB	200.2	195.7	3.6	3.9	252.0	258.3	1.1	1.1	481.3	487.6	232.3	236.8
T_6	100% NPK + Azotobactor + PSB	201.0	194.5	3.9	4.2	255.4	259.4	1.1	1.1	497.3	504.6	236.5	240.6
T_7	75% NPK	171.9	174.6	3.2	3.6	242.5	248.8	1.0	1.0	402.7	410.6	226.5	231.8
T_8	75% NPK + 5 t FYM	174.2	178.3	3.5	3.9	245.3	251.2	1.0	1.0	414.3	421.5	228.7	233.5
T_9	75% NPK + 5 t FYM+ Azo + PSB	191.4	186.4	3.6	4.2	249.9	254.9	1.0	1.0	474.0	483.9	231.5	236.7
T_{10}	100% NPK + 5 t FYM+ Azo + PSB	203.6	198.9	4.0	4.4	265.1	269.4	1.1	1.1	537.3	545.1	243.9	246.2
	S.Em.±	5.75	5.25	0.21	0.29	8.5	9.3	0.009	0.008	9.49	10.2	0.67	0.61
	C.D. (P=0.05)	17.20	15.65	0.62	0.88	25.7	28.1	0.027	0.024	28.43	30.7	1.96	1.85

Table 2: Effect of different treatments on yields and uptake of nutrients

Treatments		Grain yield (q/ha)		Stover yield (q/ha)		Biological yield (q/ha)		Nutrient uptake (kg/ha)					
								N		P		K	
		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
T_1	Control	13.6	14.2	44.5	43.7	58.1	57.9	46.8	47.1	13.1	13.6	71.1	71.6
T_2	100% NPK	44.7	45.8	67.3	66.5	112.0	112.3	106.5	107.3	25.1	25.5	109.8	110.4
T_3	100% NPK + 5 t FYM	49.7	50.6	71.7	70.2	121.4	120.8	121.2	121.6	28.8	29.3	117.1	117.9
T_4	100% NPK + Azotobactor	47.9	49.1	70.1	69.1	118.0	118.2	115.9	116.7	26.9	27.3	114.3	114.8
T_5	100% NPK + PSB	47.3	48.3	69.1	67.5	116.4	115.8	114.9	115.5	26.9	27.4	112.0	113.6
T_6	100% NPK + Azotobactor + PSB	48.8	49.7	70.8	58.4	119.6	108.1	117.6	118.4	27.9	28.2	115.7	116.2
T_7	75% NPK	40.7	42.1	65.2	63.8	105.9	105.9	95.2	96.0	22.0	22.1	95.6	96.1
T_8	75% NPK + 5 t FYM	42.9	44.6	66.7	65.3	109.6	109.9	99.9	101.2	23.3	23.4	101.7	102.3
T_9	75% NPK + 5 t FYM+ Azo + PSB	45.1	45.9	67.4	64.7	112.5	110.6	106.9	107.4	25.5	25.6	111.2	111.6
T_{10}	100% NPK + 5 t FYM+ Azo + PSB	52.7	53.6	75.6	73.6	128.3	127.2	133.7	134.3	32.2	32.4	128.7	129.4
	S.Em.±	1.50	1.30	0.97	1.30	2.47	2.6	2.76	2.81	1.26	1.25	3.51	3.57
	C.D. (P=0.05)	4.50	4.10	2.91	4.10	7.41	8.2	8.27	8.44	3.76	3.75	10.53	10.71

Table 3: Effect of different treatments on quality and production economics

Treatments		Quality attributes				Production economics							
		Protein content (%)		Protein yield (kg/ha)		Net return (Rs/ha)		B:C Ratio		Production efficiency (kg/day/ha)		Economic efficiency (Rs/day/ha)	
		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
T_1	Control	7.92	7.98	107.7	113.3	5549	6354	0.68	0.72	15.1	15.8	61.7	70.6
T_2	100% NPK	8.10	8.13	362.1	372.4	29543	30785	2.60	0.65	49.7	50.9	328.3	342.1
T_3	100% NPK + 5 t FYM	8.31	8.36	413.0	423.0	32913	34025	2.65	2.72	55.2	56.2	365.7	378.1
T_4	100% NPK + Azotobactor	8.23	8.27	394.2	406.1	29311	30501	2.56	2.61	53.2	54.6	325.7	338.9
T_5	100% NPK + PSB	8.20	8.24	387.9	398.0	28757	29870	2.51	2.57	52.6	53.7	319.5	331.9
T_6	100% NPK + Azotobactor + PSB	8.25	8.30	402.6	412.5	29790	31145	2.59	2.66	54.2	55.2	331.0	346.1

T_7	75% NPK	8.05	8.08	327.6	340.2	26257	27789	2.56	2.62	45.2	46.8	291.7	308.8
T_8	75% NPK + 5 t FYM	8.08	8.10	346.6	361.3	28098	29634	2.49	2.57	47.7	49.6	312.2	329.3
T_9	75% NPK + 5 t FYM+ Azo + PSB	8.16	8.20	368.0	376.4	29861	30712	2.62	2.66	50.1	51.0	331.8	341.2
T_{10}	100% NPK + 5 t FYM+ Azo + PSB	8.35	8.41	440.0	450.8	35508	36639	2.83	2.89	58.6	59.6	394.5	407.1
	S.Em.±	0.05	0.06	0.8	0.8	-	-	-	-	1.7	1.4	-	-
	C.D. (P=0.05)	0.15	0.18	2.3	2.5	-	-	-	-	5.0	4.6	-	-

4. Conclusion

Based on two year field experimentation and with support of the previous works, it could be inferred that performance, productivity, profitability and used efficiency of nitrogen in maize was improved by combination of organic, inorganic and bioferilizer. Application of 100% NPK + 5 t FYM+ Azotobacter + PSB was found to be more effective for improving performance, productivity, profitability and used efficiency of nitrogen in maize than all over rest of the treatments. Thus, study suggests that maize can be successfully grown under semi-arid conditions of Western Uttar Pradesh on 100% NPK + 5 t FYM+ Azotobacter + PSB and harvest maximum productivity and profitability besides, improving used efficiency of nitrogen.

5. References

1. Chandravanshi P, Chandrappa H, Hugar AY, Danaraddi Vijay S, Kumar NBT, Pasha A. Effect of integrated nutrient management on soil fertility and productivity for sustainable production in rice-maize cropping system under Bhadra command area of Karnataka Proceedings of National Conference on Harmony with Nature in Context of Environmental Issues and Challenges of the 21st Century, Special issue, The Ecoscan, 2014; 6:385-390.
2. Doberman A, Witt C, Dawe D, Abdulrachman S, Gines HC, Nagarajan R *et al*. Site- specific nutrient management for intensive rice cropping systems in Asia. Field Crops Researhc. 2002; 74:37-66.
3. Dobermann A, Witt C, Abdulrachman S, Gines HC, Nagrajan R, Son TT *et al*. Soil fertility and indigenous nutrient supply in irrigated rice domains of Asia. Agron. J. 2003; 95:913-923.
4. Dwivedi Ashish, Singh A, Tomar SS, Kumar S, Dev I, Kishore R, Singh P *et al*. Performance, Uptake and Use Efficiency of Nutrients in Maize (*Zea mays* L.) and Mashbean (Vigna mungo L.) alongwith Microbiological Properties under Intercropping System in Alluvial Soil of India J. Pure Appl. Microbio. 2015; 9(2):1233-1242.
5. Gomez KA, Gomez AA. Statistical procedure for Agricultural Research An international Rice Research Institute Book. John Willey and sons, 2nd edition. 1984, 329.
6. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd. New Delhi, 1973.
7. Kokani JM, Shah KA, Tandel BM, Nayaka P. Growth, yield attributes and yield of summer blackgram (Vigna mungo l.) as influenced by FYM, phosphorus and sulphur. Proceedings of National Conference on Harmony with Nature in Context of Environmental Issues and Challenges of the 21st Century, Special issue, The Ecoscan, 2014; VI:429-433.
8. Kumari A, Singh ON, Kumar R. Effect of integrated nutrient management on growth, seed yield and economics of garden pea (Pisum sativum L.) and soil fertility changes. J. Food Legumes. 2012; 25(2):121-124.
9. Kumawat N, Singh RP, Kumar R, Kumari A, Kumar P. Response of intercropping and integrated nutrition on production potential and profitability on rainfed pigeonpea. J. Agril. Sci. 2012; 4(7):154-162.
10. Manasa V, Hebsur NS, Malligawad LH, Shiva Kumar L, Ramakrishna B. Effect of water soluble fertilizers on uptake of major and micro nutrients by groundnut and post-harvest nutrient status in a vertisol of northern transition zone of Karnataka. The Ecoscan. 2015; 9(1-2):01-05.
11. Naresh RK, Tomar SS, Kumar D, Samsher Purushottam, Singh SP, Dwivedi Ashish *et al*. Experiences with Rice Grown on Permanent Raised Beds: Effect of Crop Establishment Techniques on Water Use, Productivity, Profitability and Soil Physical Properties. Rice Sci. 2014; 21(3):170-180.
12. Page AL. Methods of Soil Analysis: Part 2. Chemical and Microbiological Properties. American Society of Agronomy, Soil Science Society of America, Madison, WI, USA, 1982.
13. Panwar AS. Effect of integrated nutrient management in maize (*Zea mays*) - mustard (Brassica campestris var. toria) cropping system in mid hills altitude. Indian J. Agricultural Sciences. 2008; 78(1):27-31.
14. Pathak SK, Singh SB, Singh SN. Effect of integrated nutrient management on growth, yield and economic in maize (Zeamays)-wheat (Triticum aestivum) cropping system. Ind. J. Agron. 2002; 47:325-332.
15. Prasad R. Efficient fertilizer use: the key to food security and better environment. J. Trop Agric, 2009; 47:(1)7-26.
16. Satish A, Govind Gowda V, Chandrappa H, Nagaraja K. Long term effect of integrated use of organic and inorganic fertilizers on productivity, soil fertility and uptake of nutrients in rice and maize cropping system. Int. J. Sci. Nat. 2011; 2:84-88.
17. Seshaiah MP. Sorghum grain in poultry feed. In: Proc. Intl. Consultation, Chandrasekaran, A. R. Bundyopadhyay and H.I. Hall (Eds.). ICRISAT, Andhra Pradesh, India, 2000; 18-19:240-241.
18. Sharma GD, Thakur R, Som R, Kauraw DL, Kulhare PS. Impact of intergated nutrient management on yield, nutrient uptake, protein conttent of wheat (Triticum astivum) and soil fertility in a typic Haplustert. The Bioscan. 2013; 8(4):1159-1164.
19. Shete PG, Thanki JD, Baviskar VS, Bhoye KP. Yield, nutrient uptake and economics of greengram as influenced by land configuration, inorganic fertilizers and FYM levels. Green Farming. 2011; 2(4):425-427.