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Asha Kumari Sinha
Department of Soil Science and Agricultural Chemistry, Birsa Agricultural University, Ranchi, Jharkhand, India

Kumari Prerna Deep
Department of Soil Science and Agricultural Chemistry, Birsa Agricultural University, Ranchi, Jharkhand, India

Asisan Minz
Department of Soil Science and Agricultural Chemistry, Birsa Agricultural University, Ranchi, Jharkhand, India

Bhupendra Kumar
Department of Soil Science and Agricultural Chemistry, Birsa Agricultural University, Ranchi, Jharkhand, India

Sheela Barla
Department of Agronomy, Birsa Agricultural University, Ranchi, Jharkhand, India

Md. Parwaiz Alam
Department of Agronomy, Birsa Agricultural University, Ranchi, Jharkhand, India

Correspondence
Asha Kumari Sinha
Department of Soil Science and Agricultural Chemistry, Birsa Agricultural University, Ranchi, Jharkhand, India

Effect of crop residue incorporation in maize on nutrient status their uptake and yield in acid soil of Ranchi

Asha Kumari Sinha, Kumari Prerna Deep, Asisan Minz, Bhupendra Kumar, Sheela Barla and Md. Parwaiz Alam

Abstract
The experiment was conducted in *kharif* 2016 on hybrid maize comprising five treatments with and without incorporation of crop residues along with chemical fertilizers, viz. NPK (250:120:120 kg/ha), N_0PK (0:120:120 kg/ha), NP_0K (250:0:120 kg/ha), NPK_0 (250:120:0 kg/ha) and SSNM (200 kg N: 90 kg P_2O_5: 100 kg K_2O /ha) to study the effect of crop residue incorporation in hybrid maize on nutrient status. Results showed among the different treatments ample dose of fertilizers application gave highest yield 87.69 and 83.63 q/ha in with and without crop residues incorporated plots. Minimum yield obtained in the N omitted plots (16.98 and 16.00 q/ha with and without incorporation of crop residues). The highest available nitrogen, phosphorus, potassium and sulphur status was found 224.40, 117.81, 236.36 and 117.69 kg/ha and the lowest 219.81, 110.34, 208.73 and 112.70 kg/ha when crop residue was incorporated and without incorporation of crop residue respectively. The significantly ($P<0.05$) higher levels of available phosphorus of residue treated plots was found due to phosphorus - released from the decomposition of crop residues.Maximum nutrient uptake (N – 278.74 & 265.89, P – 45.77 & 43.69, K – 112.8 & 109.15 kg/ha) was obtained when ample dose of nutrients were applied and minimum (N – 48.34 & 45.39, P – 7.29 & 6.82, K – 27.35 & 26.07 kg/ha) uptake was observed in the treatments where N was omitted. Whenever uptake was compared with incorporation of crop residues and without incorporation of crop residues, total uptake of nutrients were more in crop residues incorporated plots than without incorporation of crop residues. Total nutrients uptake (N, P, K) of all treatments were higher with incorporation of crop residue. However maximum response of crop residue (N 10.52%, P 11.25% & K 8.37%) were found in the K omitted plots.

Keywords: Crop residue, Maize (Zea mays L.), Nutrient Status, Yield, Nutrient Uptake.

Introduction
Maize (*Zea mays L.*) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals. It is cultivated on nearly 150 mha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36 % (782 mt) in the global grain production. The USA has the highest productivity (> 9.6 t ha^{-1}) which is double than the global average (4.92 t ha^{-1}), whereas, the average productivity in India is 2.43 t $ha^{-1.}$ In India, maize is the third most important food crops after rice and wheat. According to advance estimate it is cultivated in 8.7 m ha (2010-11) mainly during *Kharif* season which covers 80% area. Maize in India, contributes nearly 9% in the national food basket and more than Rs. 100 billion to the agricultural GDP at current prices apart from the generating employment to over 100 million man-days at the farm and downstream agricultural and industrial sectors. Maize protein 'zein' is deficient in tryptophan and lysine, the two essential amino acids. Maize grain has significant quantities of vitamin A, nicotinic acid, riboflavin and vitamin E. Maize is low in Ca, fairly high in P.USA is the largest producer of maize contributes nearly 35% of the total production in world and highest productivity (>9.6 t ha^{-1}) which is double than the global average (4.92 t ha^{-1}). In India it is the 3rd most important food crops after rice and wheat. It contributes nearly 9% in the national food basket and averageproductivity in India is 2.43 t ha^{-1}.Crop residues has several benefits to agriculture, notably in protecting against soil erosion and improving water retention (Buerkert *et al*., 2000) [6], increasing soil organic matter (Boehm and Anderson 1997) [5], and recycling nutrients (Soon and Arshad, 2002) [19]. Whitbread *et al.* (2000) [22] reported that while more than 85% of N and P in mature wheat plants were contained in the grain, about 80% of K was contained in the straw.Net positive or negative soil nutrient balances have been observed when crop residues are either returned to the soil or removed, respectively

(Whitbread *et al*. 2003). About 25% of N and P, 50% of S and 75% of K taken up by cereal crops are retained in the crop residue, making them viable nutrient sources. Also, residues return carbon (C) to the soil, which improves soil structure, the ability of the soil to hold nutrients, and water holding capacity. The use of organic inputs such as crop residue and manures has great potential for improving soil productivity and crop yield through improvement of the soil chemical properties and nutrient supply (Abbasi *et al*., 2009) [1]. Incorporation of crop residues can contribute to sustainability mainly through improvement of soil fertility as judged by organic carbon, available P and potassium (K) content. Straw incorporation returns valuable nutrients back into the soil, particularly P and K, leading to potential economic savings through reduced additions of organic and inorganic fertilisers (HGCA, 2009) [9]. However, cereal straw can cause the 'lock up' of N in autumn as the decomposition of the C-rich straw causes soil microbes to take available nitrate or ammonium nitrogen out of the soil solution, potentially slowing the growth of seedlings over winter and adding to the need for autumn N fertiliser (Jenkinson, 1985) [11]. Straw contains useful quantities of potash (K_2O) and phosphate (P_2O_5). If straw is incorporated these nutrients are returned to the soil thus reducing the requirement for inorganic fertilisers.The effect of crop residue incorporation on build-up of soil organic carbon and impact on nutrient status in maize crop, because red and lateritic soils of Jharkhand are poor in soil fertility. Residue incorporation in soil is likely to bring about changes in the availability and transformation of essential plant nutrients, which ultimately affect the crop yield and uptake of nutrients. Keeping these in view, the present study was conducted to find out the predictive effect of crop residue incorporation on crop productivity and nutrient status of maize crop of experimental farm of Birsa Agricultural University, Ranchi, Jharkhand.

Materials and Methods

The site of the field experiment was the Research Farm of the Department of the Soil Science, BAU, Ranchi. The experimental area comes under Agro climatic Zone V (situated at $23^0 19'$ N and $83^0 17'$) and has an altitude of 625 meter above MSL (mean sea level). Field experiments were initiated in the year 2009 under an IPNI (India Programme) sponsored Programme on Nutrient Omission Plot studies to study the relative assessment of the soil on its inherent nutrient supplying capacity. During 2011-12, the experiment was modified to evaluate the effect of crop residue incorporation on crop productivity and nutrient use efficiency of maize. The total rainfall received by the area during 2016 – 2017 was 1265.2 mm with peak period of rainfall from June to September.The experiment consisted of five treatments including: T_1 - ample NPK (250: 120: 120 kg/ha), T_2 - omission of N with full P and K (-N = 0: 120: 120 NPK kg/ha), T_3 - omission of P with full N and K (-P = 250: 0: 120 NPK kg/ha), T_4 - omission of K with full N and P (-K = 250: 120: 0 NPK kg/ha) & T_5 - SSNM (200: 90: 100 NPK kg/ha) were comprised in randomized block design and replicated four times. The maize verity Pioneer – 3377 was used during the present investigation. Soil samples from the experimental plot of each treatments and replication (total 40 samples) were collected at depth 0-15 cm. The soil samples were collected at two stages i.e. pre sowing of maize crop & after harvest of maize crop.

Initial soil available nutrients in each treatment plot of the experimental site were assessed. The soil of the experimental field had sandy loam in texture and classified taxonomically as "TypicPaleustalf" with p^Hvaries from 5.39 to 5.73 and 5.35 to 5.63, organic carbon 0.41 to 0.58% and 0.38 to 0.49% and available N (191.45 to 235.59 kg/ha and 187.53 to 213.48 kg/ha), P(14.62 to 209.81 kg/ha and 12.96 to 164.81 kg/ha), K(128.32 to 336.28 kg/ha and 118.96 to 204.24 kg/ha) and available S (51.98 to 154.04 kg/ha and 50.46 to 148.19 kg/ha)with and without crop residue incorporation respectively.

The soil samples were air-dried, ground and analyzed for pH in 1:2.5 soil: water suspension, organic carbon by the Walkely and Black (1934) method, available N by alkaline potassium permanganate suggested by Subbiah and Asija (1956) [20], available P (Bray and Kurtz 1945) [7], available K by extraction of soil with neutral ammonium acetate solution at pH 7.0 (Jackson 1973) [10] and available sulphur of soil was extracted by using 0.15% $CaCl_2$ extractant in the soil: extract ratio 1:5 (Williams and Steinbergs 1959) [23] sulphate sulphur was determined turbidimetrically (Chesnin and Yein 1951) [8].

Nutrient (N, P, & K) in plant samples were analysed by standard methods as suggested to total nitrogen in plant samples were estimated by Kjeldahl Method, total phosphorous in di-acid mixture (Nitric & Perchloric acid in 10:4 ratios) and estimated by Vanadomolybdo phosphoric acid yellow colour method on double beam spectrophotometer while totalK content in the di-acid digested aliquot of plant samples were determined by flame photometer as described by Jackson (1973) [10].

Uptake of nutrients

N, P and k uptake by maize from their respective nutrient concentration in plant components by using expression:

Nutrient Uptake (Kg ha^{-1}) = Nutrient Concentration (%) X Yield (q ha^{-1})

Results and Discussion

Residue incorporation in soil is likely to bring about changes in the availability and transformation of essential plant nutrients, which ultimately affect the crop yield and uptake of nutrients (N, P & K).

Effect of Crop Residue Incorporation along with inorganic fertilizer on Maize Yield

Maize grain and straw yield was significantly affected by with and without crop residue incorporation (Table 1). The maximum yield (grain & straw) was observed in NPK (85.66 q/ha & 112.81 q/ha respectively) treated plot, when heavy dose of N, P_2O_5 & K_2O (250 kg N, 120 kg P_2O_5 and 120 kg K_2O per hectare) was added continuously. In NPK treated plot this yield was significantly higher than SSNM (grain yield 73.61 q/ha & straw yield 98.90 q/ha), NP_0K (grain yield 68.27 q/ha & straw yield 93.22 q/ha), NPK_0 (grain yield 47.11 q/ha & straw yield 64.87 q/ha) and N_0PK (grain yield 16.49 q/ha & straw yield 30.92 q/ha). When plot was treated with SSNM the yield was obtained significantly lower than NPK treated plot. It may be due to in SSNM treated plot; it was receiving 200 kg N, 90 kg P_2O_5 & 100 kg K_2O per hectare, which was less than NPK (250 kg N, 120 kg P_2O_5 and 120 kg K_2O per hectare) treated plot. It was also observed that the yield of NP_0K was significantly lower than NPK and SSNM treated plot. This may be due to this plot was not received any drop of phosphorus. It was observed that lower yield (grain & straw) was obtained in N_0PK (16.49 q/ha & 30.92 q/ha respectively) treated plot which was significantly lower than all other treatments. This may be due to no application of nitrogenous fertilizer in N_0PK treated plot.Among the entire treatments crop residue incorporated plots obtained higher yield (grain yield 59.57 q/ha & 80.85 q/ha straw yield) than without crop residue incorporated plots. Incorporation of residues on soil increased the straw yield, compared with the residues removed treatments. Similarly Shafi *et al.* (2007) [16] and Bakht *et al.* (2009) [3] reported that shoot biomass was increased with residues retention.

Effect of Crop Residue Incorporation along with Inorganic Fertilizer on Nutrient Status of Soil

Available nitrogen

The highest available nitrogen status was 239.43 kg/ha in post-harvest soil when soil was treated with ample NPK which was significantly superior to N_0PK (175.78 kg/ha) treated plot. Available N status was found minimum in the plot where no nitrogen (N_0PK) was applied. The highest available nitrogen status was found 224.40 kg/ha and the lowest 219.81 kg/ha when crop residue was incorporated and without incorporation of crop residue respectively (Table 2). Incorporation of crop residue increased the available nitrogen content of soil. It is due to mineralization of organic nitrogen present in residue (Power *et al*. 1986) [15]. Kumari (2012) [12] also reported that incorporation of crop residue increased the available nitrogen content of soil.

Available phosphorus

Among all the treatments available phosphorus status of post-harvest soil was maximum in N_0PK (222.15 kg/ha) treated plot followed by NPK (126.50 kg/ha) and NPK_0 (125.58 kg/ha) and minimum value was recorded in NP_0K (10.81 kg/ha).Table -2 also showed that the available phosphorus in crop residue incorporated plot was significantly higher (117.81 kg/ha) than without crop residue incorporated plot (110.34 kg/ha). Available phosphorus was lowest in NP_0K treated plot. This may be due to application of zero kg phosphorus in this plot, but yield was obtained every season. The significantly ($P<0.05$) higher levels of available phosphorus of residue treated plots was found due to phosphorus - released from the decomposition of crop residues. The improvement in soil pH could have also led to the solubilisation of inorganic phosphorus hence, enhancing the soil phosphorus levels. (Ogbodo, 2011). The incorporation of crop residues may increase crop-available phosphorus either directly by the process of decomposition and release of phosphorus from the biomass or indirectly by increasing the amount of soluble organic matter which are mainly organic acids that increase the rate of desorption of phosphate and thus improve the available phosphorus content in the soil (Nziguheba *et al*. 1998) [13].

Available potassium

Critical examination of the data presented in table -2 revealed that among all the treatments, available potassium was maximum in N_0PK (346.37 kg/ha) treated plot followed by NP_0K (300.94 kg/ha) and minimum value was recorded in NPK_0 (119.80 kg/ha). Available potassium of all treatments were significantly higher than NPK_0 treated plot (119.80 kg/ha) where not a single drop of potassium was applied. Available potassium of N_0PK treated plot (346.37 kg/ha) was significantly higher than NP_0K (300.94kg/ha), NPK (175.78 kg/ha) and SSNM (169.87 kg/ha). It may be attributed to poor performance of plants due to omission of nitrogen and so less potassium uptake by plants from N_0PK soil than other treatments. Perusal of data in table-2, it was also observed that available potassium in crop residue incorporated plot (236.36 kg/ha) was significantly higher than that of without crop residue incorporated plot (208.73 kg/ha). The interaction effect of treatments (N_0PK & NP_0K) and crop residue incorporation was significant. Similar result was also found by Bijay-Singh *et al*. (2003) [4] and Yadvinder-Singh *et al*. (2004) [24]. Crop residues contain large quantities of potassium, and their recycling can markedly increase potassium availability in soils. Effect of continuous application of crop residue with recommended dose of fertilizer showed a noticeable increase in available potassium content of soil. It may be attributed to poor growth of plants due to nitrogen and phosphorus deficiency and so lower potassium uptake by plants from soil.

Available sulphur

Among all the treatments available sulphur (table-2) in crop residue incorporated plot was significantly higher (117.69 kg/ha) than that of without crop residue incorporated plot (112.70 kg/ha). The highest available sulphur was recorded in N_0PK (155.56 kg/ha) treated plot followed by NPK_0 (141.35 kg/ha), NPK (118.29 kg/ha) and SSNM (114.49 kg/ha) respectively and minimum value was recorded in NP_0K (46.30 kg/ha). Available sulphur of NP_0K treated plot was significantly lower than all other treatments. These results are in agreement with the work of Singh *et al*. (2009) [18] in red soil of Ranchi. They reported that residue incorporation increased the availability of Sulphur. The increase in the available sulphur with the application of fertilizer might be due to the addition of SSP which contained about 12% of S. These results are in conformity with the findings of Sharma and Subehia (2014) [17], addition of wheat straw and green manure contributed an appreciable amount of sulphur in soil.

Effect of Crop Residue Incorporation along with Inorganic Fertilizer on Nutrient Uptake of Maize

N uptake

Application of crop residues significantly increased the N uptake, pooled over crop residue addition, with increasing rate of N up to the highest level (N_{250}) in NPK treated plot (Table-3). Addition of crop residues increased the N uptake significantly over no crop residues. Among the entire treatments crop residue incorporated plot showed higher N uptake by maize crop than without crop residue incorporated plots. Kumari (2012) [12] also reported, the residues incorporation increase the N uptake in grain and straw. The maximum N uptake by grain, straw and total N uptake were recorded in treatment NPK (51.39, 33.84 & 85.24 kg/ha respectively) followed by SSNM $>NP_0K > NPK_0 > N_0PK$ respectively. The N uptake by grain, straw and total in treatment NPK was significantly higher than other treatments and N uptake in N_0PK treatments was significantly lower than other treatments. N uptake of NP_0K was showed at par with SSNM. Aziz, *et al*. (2010) [2], and Kumari (2012) [12] they found thataddition of organic matter improves soil nutrient availability and uptake by plants while with the increase in soil organic matter, N and P availability also increases.

P uptake

A perusal of data intable- 4indicated thatamong the entire treatments crop residue incorporated plot showed higher P uptake by maize crop than without crop residue incorporated plots.The maximum P uptake was recorded in treatment NPK (grain 21.41, straw 22.56 & total uptake 43.97 kg/ha) followed by SSNM (grain 18.39, straw 19.78 & total uptake

38.18 kg/ha), NP_0K (grain 17.06, straw 17.32 & total uptake 34.39 kg/ha) and NPK_0 (grain 11.62, straw 12.97 & total uptake 24.59 kg/ha) and minimum uptake was observed in the treatment N_0PK (grain 4.12, straw 6.18 & total uptake 10.30 kg/ha). The P uptake in treatment NPK was significantly higher than other treatments and P uptake in N_0PK treatment was significantly lower than other treatments. Total P uptake by the maize in NPK treatment was significantly higher than all the other treatments. The uptake of P decreased in N & P omitted plots (N_0PK &NP_0K).

K uptake

The data (Table 5) revealed that maximum K uptake was recorded in treatment NPK (grain 25.70, straw 112.81 & total uptake 138.51 kg/ha) followed by SSNM (grain 22.06, straw 98.90 & total uptake 120.98 kg/ha), NP_0K (grain 20.48, straw 91.32 & total uptake 111.80 kg/ha) and NPK_0 (grain 13.94, straw 64.87 & total uptake 78.81 kg/ha) and minimum uptake was observed in the treatment N_0PK (grain 4.94, straw 30.92 & total uptake 35.87 kg/ha). The K uptake in treatment NPK (grain 25.70, straw 112.81 & total uptake 138.51 kg/ha) was significantly higher than other treatments and K uptake in N_0PK (grain 4.94, straw 30.92 & total uptake 35.87 kg/ha) treatment was significantly lower than other treatments. K uptake of NP_0K (grain 20.48, straw 91.32 & total uptake 111.80 kg/ha) was showed at par with SSNM (grain 22.06, straw 98.90 & total uptake 120.98 kg/ha). Among the entire treatments crop residue incorporated plot showed higher K uptake by maize crop than without crop residue incorporated plots. The increase in K concentration, with addition of organic matter may be attributed to K concentration of organic matter which improved root growth. Better root growth is responsible increased nutrient uptake in plants. These results are in agreement with the findings of Aziz *et al.*, 2010 [2]. However maximum response of crop residue (N 10.52%, P 11.25% & K 8.37%) were found in the K omitted plots.

The per cent response of maize to inorganic sources of nitrogen was greater than that of organic sources due to higher amount of nitrogen added through inorganic source than the organic one (crop residue) and it was found maximum in K omitted plot comparison to all the treatments (Table- 3,4 & 5).

Conclusions

It is inferred in the present study that incorporation of crop residue in soil is not only increasing the yield, but it also enhances the other soil fertility parameters, which is necessary to achieve a sustainable production and minimize the depletion of nutrient content of the soil for the longer period. However, consecutive few years studies will give better picture of the soil health status with this set of recommendation over time. Available nutrients in all treatments of crop residue incorporated plots was slightly higher than their respective treatments of without crop residue incorporated plot. Total uptake of nutrient was more in crop residue incorporated plot than without crop residue incorporated plot. The incorporation of crop residue can save and substitute inorganic potassic fertilizer up to some extent and it also improve soil health.

Table 1: Effect of wheat crop residue incorporation on hybrid maize yield (q/ha)

Treatments	Grain yield			Straw yield		
	CR	CR_0	Mean	CR	CR_0	Mean
NPK	87.69	83.63	85.66	113.9	111.72	112.81
N_0PK	16.98	16.00	16.49	31.63	30.21	30.92
NP_0K	68.61	67.93	68.27	93.25	94.10	93.22
NPK_0	48.99	43.99	47.11	67.15	62.55	64.87
SSNM	75.59	71.54	73.61	99.22	98.58	98.90
Mean value	59.57	56.89		80.85	79.44	
CD (0.05)	8.11			11.29		
CV (%)	6.75%			6.83%		

Table 2: Effect of wheat crop residue incorporation on post-harvest Nutrient status of soil

Treatments	Avl. N(kg/ha)			Avl. P(kg/ha)			Avl. K(kg/ha)			Avl. S(kg/ha)		
	CR	CR_0	Mean	CR	CR_0	Mean	CR	CR_0	Mean	CR	CR_0	Mean
NPK	255.53	238.34	239.43	145.11	132.9	126.50	183.32	168.24	175.78	129.28	121.31	118.29
N_0PK	178.45	173.11	175.78	242	227.31	222.15	354.32	338.5	346.37	167.81	156.32	155.56
NP_0K	253.53	236.6	235.06	11.02	10.61	10.815	342.4	259.48	300.94	49.18	45.92	46.30
NPK_0	242.2	222.5	224.85	146.41	129.75	125.58	125.84	113.76	119.80	152.09	143.61	141.35
SSNM	252.32	233.5	235.41	104.76	91.13	85.320	176.04	163.7	169.87	124.62	117.36	114.49
Mean value	224.40	219.81		117.81	110.34		236.36	208.73		117.69	112.70	
CD (0.05)	20.35			11.43			13.98			6.22		
CV (%)	4.44			4.85			3.04			2.62		

Table 3: Effect of wheat crop residue incorporation on N uptake (kg/ha) of maize

Treatments	Grain uptake			Straw uptake			Total uptake			%of response of CR
	CR	CR_0	Mean	CR	CR_0	Mean	CR	CR_0	Mean	
NPK	52.61	50.18	51.39	34.17	33.51	33.84	86.78	83.69	85.24	3.69
N_0PK	10.18	9.60	9.89	9.49	9.06	9.27	19.67	18.66	19.17	5.44
NP_0K	41.16	40.75	40.96	27.97	28.23	28.10	69.13	68.98	69.06	0.21
NPK_0	29.39	26.39	27.89	20.14	18.76	19.46	49.53	45.15	47.35	9.69
SSNM	45.35	42.92	44.13	29.76	29.57	29.67	75.12	72.56	73.84	3.52
Mean value	35.74	33.97		24.31	23.83		60.05	57.81		
CD (0.05)	5.05			3.36			7.20			
CV (%)	7.03			6.85			5.92			

Table 4: Effect of wheat crop residue incorporation on P uptake (kg/ha) of maize

Treatments	Grain uptake			Straw uptake			Total uptake			%of response of CR
	CR	CR_0	Mean	CR	CR_0	Mean	CR	CR_0	Mean	
NPK	21.92	20.90	21.41	22.78	22.34	22.56	44.70	43.25	43.97	3.35
N_0PK	4.24	4.00	4.12	6.32	6.04	6.18	10.57	10.04	10.30	5.28
NP_0K	17.15	16.98	17.06	18.65	15.99	17.32	35.80	32.98	34.39	8.55
NPK_0	12.24	10.99	11.62	13.43	12.51	12.97	25.68	23.50	24.59	9.26
SSNM	18.89	17.88	18.39	19.84	19.71	19.78	38.74	37.62	38.18	2.96
Mean value	14.89	14.15		16.20	15.32		31.10	29.48		
CD (0.05)	2.10			2.23			3.67			
CV (%)	7.03			6.85			5.85			

Table 5: Effect of wheat crop residue incorporation on K uptake (kg/ha) of maize

Treatments	Grain uptake			Straw uptake			Total uptake			%of response of CR
	CR	CR_0	Mean	CR	CR_0	Mean	CR	CR_0	Mean	
NPK	26.30	25.09	25.70	113.90	111.72	112.81	140.21	136.81	138.51	2.49
N_0PK	5.09	4.80	4.94	31.63	30.21	30.92	36.73	35.01	35.87	4.91
NP_0K	20.58	20.37	20.48	93.25	89.39	91.32	113.83	109.77	111.80	3.69
NPK_0	14.69	13.19	13.94	67.15	62.55	64.87	75.74	81.88	78.81	8.10
SSNM	22.67	21.46	22.06	99.22	98.58	98.90	121.90	120.07	120.98	1.52
Mean value	17.87	16.98		81.04	78.49		98.91	95.48		
CD (0.05)	2.52			11.19			12.51			
CV (%)	7.02			6.80			6.24			

References

1. Abbasi MK, Mushtaq A, Tahir MM. Cumulative effects of white clover residues on the changes in soil properties, nutrient uptake, growth and yield of maize crop in the sub-humid hilly region of Azad Jammu and Kashmir, Pakistan. African Journal of Biotechnol. 2009; 8(10):2184-2194.
2. Aziz T, Ullah S, Sattar A, Nasim M, Farooq M, Khan MM. Nutrient Availability and Maize (*Zea mays* L.) Growth in Soil Amended with Organic Manures. International Journal of Agriculture and Biology. 2010; 12:621-624.
3. Bakht J, Shafi M, Jan MT, Shah Z. Influence of crop residues management, cropping system and N fertilizer on soil N and C dynamics and sustainable wheat production. Soil and Tillage Research. 2009; 104:233-240.
4. Bijay-Singh, Nayyar VK, Singh J, Singh Y. Management of crop residues in rice-wheat cropping system in the IndoGangetic plains. In: Nutrient Management for Sustainable Rice-Wheat Cropping System, National Agricultural Technology Project, Indian Council of Agricultural Research, New Delhi and Punjab Agricultural University, Ludhiana, India. 2003, 286-301.
5. Boehm MM, Anderson DW. A landscape-scale study of soil quality in three prairie farming systems. Soil Science Society America Journal. 1997; 61:1147–1159.
6. Buerkert A, Bationo A, Dossa K. Mechanisms of residue mulch-induced cereal growth increase in West Africa. Soil Science Society America Journal. 2000; 64:346-358.
7. Bray RH, Kurtz LT. Determination of total organic and available forms of phosphorus in soils. *Soil Sci*ence. 1945; 59:39-42.
8. Chesnin L, Yien CH. Turbidimetric determination of sulphur. Soil Science Society of America Proceedings. 1951; 15:134-136.
9. HGCA. Information Sheet 05: Assessing the nutrient content of cereal straw. HGCA, London, 2009.
10. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, 1973.
11. Jenkinson D. How straw incorporation affects the nitrogen cycle. In: J Hardcastle (ed.) Straw, Soils and Science. AFRC, London. 1985.
12. Kumari S. Effect of crop residue management on nutrient dynamics under maize-wheat sequenceinalfisol of Ranchi. *M.Sc. Thesis*, Department of soil science & Agricultural chemistry, Birsa agricultural university, Ranchi, 2012.
13. Nziguheba G, Palm CA, Buresh RJ, Smithson PC. Soil Phosphorus Fractions and Adsorption as Affected by Organic and Inorganic Sources. Plant and Soil, 1998, 159-168.
14. Ogbodo EN. Effect of crop residue on soil chemical properties and rice yields on an ultisols at Abakaliki, Southeastern Nigeria. America Eurasian Journal Sustain Agriculture. 2009; 3(3):442-447.
15. Power JP, Wilhelm WW, Doran JW. Crop residue effects on soil environment and dry land maize and soybean production. Soil and Tillage Research. 1986; 8:101-111.
16. Shafi MJ, Bakht MT, Shah Z. Soil C and N dynamics and maize (*Zea mays* L.) yield as affected by cropping systems and residues management in North-Western Pakistan. Soil and Tillage Research. 2007; 94:520-529.
17. Sharma U, Subehia SK. Effect of Long-Term Integrated Nutrient Management on Rice (*Oryza sativa L.*) - Wheat (*Triticum aestivum L.)* Productivity and Soil Properties in North-Western Himalaya, Journal of Indian Society of Soil Science. 2014; 62(3):248-254.
18. Singh AK, Sarkar AK, Mishra B. Long-term effect of residue incorporation on crop yield, nutrient uptake and availability of plant nutrients in an acid soil. Indian Journal of Agricultural Sciences. 2009; 71(1):70-72.
19. Soon YK, Arshad MA. Comparison of the decomposition and N and P mineralization of canola, pea and wheat residues. Biology and Fertility of Soils. 2002; 36:10-17.
20. Subbiah BV, Asija GL. A rapid procedure for estimation of available nitrogen in soils. Current Science 1956; 25:259-260.
21. Walkley A, Black IA. An examination of Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Science. 1934; 37:29-37.
22. Whitbread AM, Blair GJ, Lefroy RDB. Managing legume leys, residues and fertilizers to enhance the sustainability

of wheat cropping systems in Australia. Soil Tillage Research. 2000; 54:63-75.

23. Williams CH, Steinbergs H. Soil sulphur fractions as chemical indices of available sulphur in some Austraian soil. Australian Journal of Agricultural Research. 1959; 10:340-352.
24. Yadvinder-Singh, Bijay-Singh, Ladha JK, Khind CS, Khera TS. Effects of Residue Decomposition on Productivity and Soil Fertility in Rice–Wheat Rotation. Soil Science Society of America. 2004; 68:854-864.