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Response of maize-based cropping system on nutrients uptake under irrigated situation of Jharkhand

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Abstract
A two year field experiment was conducted during 2023-24 and 2024-25 at Krishi Vigyan Kendra, Jamtara to study the impact of maize based cropping system on nutrient uptake and content by maize crop. Adopted the all crop management practice s and availability of input are sufficient in research farm. The experiment was consisted of 9 treatments T_1-Maize - fallow, T_2-Maize - wheat, T_3-Maize (Green cob) - toria - wheat, T_4-Maize (Green cob) - toria - chickpea, T_5-Maize - pea - Greengram, T_6-Maize - linseed - Greengram, T_7-Maize - lentil - Greengram, T_8-Maize - chickpea - Greengram and T_9-Maize - potato - Greengram with three times replications in Randomized Block Design. The highest N content in maize grain was recorded 1.33% and 1.23% during 2023-24 and 2024-2025 under Maize - Chickpea- Greengram and Maize - Pea- Greengram respectively, P content in grain also highest (0.210% and 0.199%) in Maize - Pea- Greengram cropping system while K content in both grain and stover was highest (0.296% and 0.895%) in Maize - Chickpea - Greengram during 1 st year. The pooled NPK uptake of grain and stover was significantly increased inclusion of pulses crop in cropping system. The highest N (83.34 and 55.43 kg / ha), P (13.30 and 7.72 kg / ha) and K (18.42 and 89.73 kg / ha) grain and stover respectively recorded under treatment T_5 (Maize - Pea- Greengram) cropping system.

Keywords: Cropping system, NPK, nutrients content and uptake**,** maize

1. Introduction
Maize is the third most important cereal crop in India after rice and wheat and is grown in a wide range of environments, extending from extreme semi-arid to sub-humid and humid regions Jain *et al* (2025) [1]. Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals Vidadala, R *et al* (2025) [6]. It accounts for around 10 per cent of total food grain production in the country. The diversification of maize cropping systems offers farmers an opportunity to optimize land use, enhance income generation and improve overall farm sustainability. Furthermore, intensification of maize-based systems, where productivity is increased by improving inputs and practices, is crucial for addressing the growing demand for food Tripathi, S. C (2025) [5]. Mostly, inappropriate cropping practices such as continuous cereal-based rotations involving exhaustive crops like potato and 'Boro' rice and chemical fertilization can overexploit irrigation and create imbalances of primary nutrients as well as multi-nutrient deficiencies and significant deterioration of soil physical quality (Saha *et al.*, 2021). On the contrary, rational cropping practices such as inclusion of legume and forage crops, manure incorporation, crop residue recycling etc Misra, S., and Ghosh, A. (2024) [2]. Not only enhances farmers' profitability from the same farm unit but also can significantly increase the soil organic carbon storage, improves soil structure, increases nutrient recycling, improves soil microbial biomass, therefore, enhances soil quality which collectively enhances agro-ecosystem services. With the above facts under consideration, these studies were therefore initiated to know the Response of maize-based cropping system on uptake of nutrients.

2. Materials and Methods
The experiment was conducted at Instructional Farm of Krishi Vigyan Kendra, Jamtara for two

consecutive years in during rainy (*kharif*), winter (*rabi*) and summer (*zaid*) seasons of 2023-24 and 2024-25. The research area are situated nearby district head quarter on a latitude of $24^{0}25^{"}$ N and longitude $87^{0}24^{"}$ E with an altitude of 235 meters above the mean sea level in Santhal Pargana region of Jharkhand state. The soil during 2024, the starting year of the experiment, was well drained, loam in texture with pH 5.9, bulk density 1.39 g/cm^3, CEC 5.4 mmhos, textural class sandy clay loam, organic carbon 3.9 g/kg, available N 228.0 kg/ha, available P 18 kg/ha and available K_2O 122.7 kg/ha. There were 9 treatments, out of which 6 are included in legume crops and rest 3 are cereals based cropping system. The treatments were compared in randomized block design with 3 replications. The variety used for maize, wheat, toria, chickpea, pea, linseed, lentil, potato and Greengram crop was 'DMH-121, DBW-187, Tapeshwari, Birsa Chann-3, Dantewada Field pea-1, Birsa Tisi-2, WBL-77, Kufri Ashoka and IPM 2-3 respectively.

Table 3.1: Details of maize based cropping system and their symbol

Sl. No.	Treatments	Symbol used
1.	Maize - fallow	T_1
2.	Maize - wheat	T_2
3.	Maize (Green cob) - toria - wheat	T_3
4.	Maize (Green cob) - toria - chickpea	T_4
5.	Maize - pea - Greengram	T_5
6.	Maize - linseed - Greengram	T_6
7.	Maize - lentil - Greengram	T_7
8.	Maize - chickpea - Greengram	T_8
9.	Maize - potato - greengram	T_9

The proper crop geometry maintain of all crops at the time of sowing. The general recommended dose of N, P and K applied all crops. the distribution of fertilizer application, full doses of phosphate as diammonium phosphate (DAP) and potash as muriate of potash were applied as basal dressing in rows before seeding in all the crops. Nitrogen both in maize, wheat, toria and potato was applied in spilits does.

Nitrogen, phosphorus and potassium content in grain and straw of different crops in maize based crooping system were estimated at maturity. The plant sample (tuber and stover) were collected separately from each crops and treatment at harvest time. The samples were ground in the Willey's mill after drying in oven at $60{\cdot}5^{0}$C temperature for 48-50 hours. The plant material was then passed through 30 mesh sieve and used for determination of N, P and K content. Percent nutrient content of these materials were analyzed chemically in laboratory by following the standard procedures Nicholas and Nason (1957) and Jackson (1973). Nutrient uptake was computed by multiplying nutrient content (%) of grain and stover with respective yield (kg ha^{-1}).

3. Results and Discussion

3.1 Nutrient content

Nutrient content in maize under different cropping system have been presented in Table 3.2.

3.1.1 Nitrogen content in grain and stover of maize

It can be observed that cropping sequences involving leguminous crop recorded higher N content in general. Data on N content in maize grain (%) of different cropping sequences revealed that in general, sequences involving summer greengram resulted in markedly higher N content than sequences without greengram during both the years of experiment. The maize-chickpea-greengram sequence recorded highest nitrogen content (1.333%) during 2023-24 and maize-pea-greengram sequence recorded highest nitrogen content (1.223%) during 2024-25. However, maize (green cob)-toria-chickpea recorded lower N content (0.674 and 0.631% during 2023-24 and 2024-25, respectively) during both years of investigation. Higher N content (0.524%) in maize stover was found during 2023-24 under maize-potato-greengram sequence and the same during 2024-25 was recorded under maize-pea-greengram sequence (0.507%). However, lower nitrogen content was observed under maize (green cob)-toria-chickpea cropping sequence (0.302 and 0.335% in 2023-24 and 2024-25, respectively). Maize grain under maize-chickpea-greengram recorded higher N content (1.33%) over maize-wheat sequence except maize-fallow system, while maize-potato-greengram sequence recorded higher N content in maize stover (0.52%) in 1st year. However, maize-pea-greengram recorded higher N content in stover (0.507%) in 2nd year of experiment.

3.1.2 Phosphorus content in grain and stover of maize

Among various systems, higher P content was recorded in maize grain under the maize-pea-greengram cropping system (0.210%) during 2023-24 and during 2nd year 2024-25 was recorded with maize-chickpea-greengram and maize-pea-greengram (0.199%). Higher P content in maize stover (0.73%) was recorded under maize-pea-greengram, maize-linseed-greengram, maize-lentil-greengram, maize-chickpea-greengram and maize-potato-greengram during 2023-24 while during 2024-25 higher P content (0.70%) was recorded under maize-pea-greengram, maize-lentil-greengram and maize-chickpea-greengram cropping sequences. However, lower P content in stover was observed under maize (green cob)-toria-wheat cropping sequence (0.042 and 0.045% during 2023-24 and 2024-25, respectively).

3.1.3 Potassium content in grain and stover of maize

Higher K content in maize grain (0.296%) and maize stover (0.895%) was observed in maize-chickpea-greengram cropping sequence during 2023-24 while higher K content in maize grain (0.270%) in maize-potato-greengram sequence during 2024-25. However, lower K content in grain was recoded under maize (green cob)-toria-wheat sequence (0.142 and 0.121% during 2023-24 and 2024-25, respectively) and lower K content in stover under maize (green cob)-toria-chickpea sequence (0.525 and 0.481% during 2023-24 and 2024-25, respectively).

3.2 Nutrient Uptake

Inclusion of other pluses in sequences also significantly influenced the NPK removal by grain, stover and total nutrient uptake by maize than the other systems. Cropping system with pea as *rabi* crop recorded significantly higher NPK uptake by maize grain, stover as well as total NPK uptake over rest of the cropping sequences (3.3 3.4 and 3.5 respectively).

3.2.1 Nitrogen

Data presented in table 3.3 indicates that cropping system significantly influenced the nitrogen uptake by grain, stover as well as total nitrogen uptake (kg ha^{-1}) by maize during both the year of study. Significantly higher N uptake by maize grain (83.37 kg ha^{-1}), maize stover (55.43 kg ha^{-1}) and total N uptake (138.82 kg ha^{-1}) was observed in maize-pea-greengram sequence

in pooled analysis which was at par with maize-chickpea-greengram sequence (83.05, 55.05 and 138.10 kg ha^{-1}, respectively). While cropping sequence maize (green cob)-toria-chickpea recorded significantly lower N uptake by grain, stover and total N uptake (67.83, 47.02 and 114.65 kg ha^{-1}, respectively).

3.2.2 Phosphorus uptake

Data on P uptake by grain, stover and total P uptake (kg ha^{-1}) of different crop sequences revealed that in general, sequences involving summer greengram resulted in markedly higher P uptake than sequence without greengram during both the years of experiment (Table 3.4). In pooled data, significantly higher P uptake was recorded under maize-pea-greengram sequence (13.40, 7.72 and 21.12 kg ha^{-1} P uptake by grain, stover and total, respectively) followed by maize-chickpea-greengram sequence (13.31, 7.67 and 20.97 kg ha^{-1} P uptake by grain, stover and total, respectively). However, cropping sequence maize (green cob)-toria-wheat recorded significantly lower P uptake by grain, stover and total P uptake (11.02, 6.40 and 17.42 kg ha^{-1}, respectively).

3.2.3 Potassium Uptake

Potassium uptake by grain, stover and total K uptake by maize under different crop sequences differed significantly during both the years of experimentation (Table 3.5). From pooled analysis, it can be observed that higher quantity of K was removed under maize-pea-greengram (18.42, 89.73 and 108.15 kg ha^{-1} K uptake by grain, stover and total K uptake, respectively) followed by maize-chickpea-greengram (18.38, 89.51 and 107.89 kg ha^{-1} K uptake by grain, stover and total K uptake, respectively). On the contrary, the lower values were recorded under maize-wheat sequence (13.59, 74.28 and 87.87 kg ha^{-1} K uptake by grain, stover and total K uptake, respectively). This might be due to the higher yield and higher NPK content in maize in the system. The significantly lower NPK removal was recorded in maize (green cob)-toria-wheat cropping sequence, might be due to the lower NPK content as well as lower yield. The findings are in conformity with Shanwad *et al.* (2010) [4], Surendra and Sharanappa (2000) and Rajkumara *et al.* (2012) [3].

Table 3.1: Effect of Diversification and intensification of maize-based cropping system on Nitrogen, phosphorus and potassium content in maize

Treatments	Nitrogen content (%)				Phosphorus content (%)				Potassium content (%)			
	2023-24		2024-25		2023-24		2024-25		2023-24		2024-25	
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
T_1: Maize-Fallow	1.325	0.514	1.215	0.500	0.208	0.072	0.196	0.069	0.287	0.856	0.263	0.768
T_2: Maize-Wheat	1.324	0.514	1.215	0.499	0.207	0.071	0.195	0.069	0.285	0.854	0.261	0.767
T_3: Maize (Green Cob)-Toria-Wheat	0.684	0.304	0.632	0.337	0.110	0.042	0.103	0.045	0.142	0.532	0.121	0.481
T_4: Maize (Green Cob)-Toria- Chickpea	0.674	0.302	0.631	0.335	0.111	0.042	0.104	0.045	0.144	0.525	0.122	0.481
T_5: Maize-Pea-Greengram	1.332	0.516	1.223	0.507	0.210	0.073	0.199	0.070	0.294	0.890	0.270	0.773
T_6: Maize-Linseed-Greengram	1.328	0.519	1.218	0.503	0.209	0.073	0.197	0.069	0.291	0.879	0.266	0.770
T_7: Maize-Lentil-Greengram	1.330	0.518	1.220	0.504	0.209	0.073	0.198	0.070	0.293	0.884	0.267	0.771
T_8: Maize-Chickpea-Greengram	1.333	0.516	1.222	0.506	0.210	0.073	0.199	0.070	0.296	0.895	0.269	0.772
T_9: Maize-Potato-Greengram	1.327	0.521	1.217	0.501	0.208	0.073	0.197	0.069	0.288	0.866	0.264	0.769
S.Em±	0.034	0.015	0.033	0.013	0.006	0.002	0.005	0.002	0.008	0.028	0.008	0.024
CD (p=0.05)	0.104	0.044	0.099	0.040	0.018	0.007	0.016	0.006	0.025	0.083	0.023	0.072
CV (%)	5.03	5.42	5.22	4.90	5.40	5.85	5.31	5.55	5.66	5.98	5.71	5.82

Table 3.2: Effect of Diversification and intensification of maize-based cropping system on nitrogen uptake in maize

Treatments	Nitrogen uptake						Total nitrogen uptake		
	Grain			Stover					
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
T_1: Maize-Fallow	78.79	74.28	76.54	51.17	53.42	52.30	129.97	127.88	128.92
T_2: Maize-Wheat	78.09	73.04	75.56	50.99	53.19	52.09	129.08	125.82	127.45
T_3: Maize (Green Cob)-Toria-Wheat	68.76	66.89	67.83	44.06	49.98	47.02	112.82	116.47	114.65
T_4: Maize (Green Cob)-Toria- Chickpea	67.70	68.71	68.21	44.90	50.93	47.91	112.60	119.44	116.02
T_5: Maize-Pea-Greengram	82.13	84.56	83.34	51.99	58.87	55.43	134.12	143.52	138.82
T_6: Maize-Linseed-Greengram	80.49	78.91	79.70	51.93	55.09	53.51	132.42	133.95	133.18
T_7: Maize-Lentil-Greengram	81.23	81.47	81.35	51.99	56.38	54.19	133.22	137.96	135.59
T_8: Maize-Chickpea-Greengram	82.74	83.37	83.05	52.26	57.83	55.05	135.00	141.20	138.10
T_9: Maize-Potato-Greengram	79.93	77.17	78.55	51.76	54.97	53.37	131.69	132.29	131.99
S.Em±	4.87	4.57	3.34	3.04	3.22	2.21	6.16	6.69	4.55
CD (p=0.05)	14.73	13.81	9.67	9.18	9.75	6.41	18.65	20.25	13.18
CV (%)	10.85	10.34	10.60	10.49	10.24	10.37	8.35	8.85	8.61

Table 3.3: Effect of Diversification and intensification of maize-based cropping system on phosphorus uptake in maize

Treatments	Phosphorus uptake						Total phosphorus uptake		
	Grain			Stover					
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
T_1: Maize-Fallow	12.37	12.01	12.19	7.19	7.40	7.29	19.56	19.40	19.48
T_2: Maize-Wheat	12.17	11.68	11.93	7.10	7.36	7.23	19.27	19.04	19.15
T_3: Maize (Green Cob)-Toria-Wheat	11.13	10.92	11.02	6.05	6.74	6.40	17.18	17.66	17.42
T_4: Maize (Green Cob)-Toria- Chickpea	11.17	11.31	11.24	6.18	6.90	6.54	17.36	18.22	17.79
T_5: Maize-Pea-Greengram	12.96	13.84	13.40	7.32	8.11	7.72	20.28	21.95	21.12
T_6: Maize-Linseed-Greengram	12.67	12.78	12.72	7.31	7.62	7.46	19.97	20.40	20.19
T_7: Maize-Lentil-Greengram	12.80	13.24	13.02	7.31	7.83	7.57	20.11	21.07	20.59
T_8: Maize-Chickpea-Greengram	13.06	13.56	13.31	7.35	7.98	7.67	20.41	21.54	20.97
T_9: Maize-Potato-Greengram	12.53	12.50	12.51	7.24	7.52	7.38	19.77	20.02	19.90

S.Em±	0.74	0.73	0.52	0.42	0.43	0.30	4.57	0.99	0.70
CD (p=0.05)	2.24	2.20	1.50	1.27	1.30	0.87	13.81	3.00	2.03
CV (%)	10.42	10.12	10.27	10.39	9.95	10.16	10.34	8.63	8.76

Table 3.4: Effect of Diversification and intensification of maize-based cropping system on potassium uptake in maize

Treatments	Potassium uptake						Total potassium uptake		
	Grain			Stover					
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
T_1: Maize-Fallow	17.11	16.08	16.60	85.20	82.17	83.68	102.31	98.26	100.28
T_2: Maize-Wheat	16.84	15.67	16.25	84.30	81.74	83.02	101.14	97.41	99.27
T_3: Maize (Green Cob)-Toria-Wheat	14.34	12.84	13.59	77.09	71.46	74.28	91.44	84.30	87.87
T_4: Maize (Green Cob)-Toria- Chickpea	14.47	13.27	13.87	77.95	73.07	75.51	92.42	86.34	89.38
T_5: Maize-Pea-Greengram	18.18	18.66	18.42	89.69	89.76	89.73	107.87	108.43	108.15
T_6: Maize-Linseed-Greengram	17.59	17.22	17.41	87.92	84.53	86.22	105.51	101.75	103.63
T_7: Maize-Lentil-Greengram	17.89	17.83	17.86	88.80	86.47	87.63	106.69	104.31	105.50
T_8: Maize-Chickpea-Greengram	18.41	18.35	18.38	90.76	88.27	89.51	109.17	106.61	107.89
T_9: Maize-Potato-Greengram	17.29	16.78	17.03	85.96	83.49	84.72	103.25	100.26	101.75
S.Em±	1.05	0.92	0.70	5.07	4.69	3.45	5.51	5.04	3.73
CD (p=0.05)	3.16	2.78	2.01	15.33	14.20	10.00	16.66	15.26	10.82
CV (%)	10.72	9.75	10.26	10.29	9.88	10.09	9.33	8.86	9.11

Conclusion

The study evaluated enhanced NPK uptake in grain and stover was found significantly higher under inclusion of legume crops in maize based cropping system compared to inclusion of cereals crops in cropping system. The pooled and both year NPK uptake was also found to be higher in addition of legume crops during *rabi* season (*viz*. T_5 maize-pea-greengram) under in maize based cropping system. The inclusion of legume crops in maize based cropping systems not only increased nutrient uptake also improve soil fertility.

References

1. Jain N, Verma H, Deo A, Bora K, Bhatia A, Chakrabarti B, *et al*, Aggarwal PK. Effect of climate change adaptation options on maize yield across different agro-climatic zones in South Asia: a meta-analysis. 2025.
2. Misra S, Ghosh A. Agriculture paradigm shift: a journey from traditional to modern agriculture. In: Biodiversity and Bioeconomy. Elsevier; 2024. p. 113-141.
3. Rajkumara S, Gundlur SS, Khot AB. Effect of continuous application of organics to supply nitrogen and phosphorus on maize (*Zea mays* L.) and chickpea (*Cicer arietinum*) under irrigated condition. Indian J Agric Sci. 2012;82(10):892-895.
4. Shanwad UK, Aravindkumar BN, Hulihalli UK, Surwenshi A, Reddy M, Jalageri BR. Integrated nutrient management in maize-Bengal gram cropping system in northern Karnataka. Res J Agric Sci. 2010;1(3):252-254.
5. Tripathi SC, Kumar N, Venkatesh K, Meena RP. Enhancing energetics, system productivity, profitability and soil fertility in maize-based cropping system by conservation vis-à-vis conventional agriculture in north-west India. Int J Plant Prod. 2025;19:117-130.
6. Vidadala R, Kumar V, Rout S, Sil P, Teja V, Rahimi M. Genetic analysis of quality protein maize (QPM): a review. Cereal Res Commun. 2025;53(1):81-99.