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EFFECT OF VARIOUS NUTRIENT MANAGEMENT PRACTICES ON SOYBEAN BASED CROPPING SYSTEM UNDER CHHATTISGARH PLAIN OF INDIA

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ABSTRACT

A field experiment was conducted during the rabi season of 2021–22 at the Research Farm of IGKV, The geographical coordinates for Labhandih (Labhandi), Raipur, Chhattisgarh are approximately: Decimal degrees: 21.2465° N, 81.7016° E DMS (Degrees, Minutes, Seconds): ~ 21° 14′ 47″ N, 81° 42′ 6″ E with an altitude of 289.56 m above mean sea level. The experiment was laid out in a strip plot design with three replications, comprising six nutrient management practices and four based on cropping systems. The nutrient management treatments included NM_1: 100% organic, NM_2: 50% inorganic + natural farming (NF), NM_3: 50% organic + 50% inorganic, and NM_4: 25% nutrient through organic + 25% inorganic + 5 t FYM ha^{-1}. The cropping system treatments were CS_1: soybean–sweet corn, CS_2: soybean–moong bean, CS_3: soybean–cole crop, and CS_4 : soybean–tomato.

The soil of the experimental site was neutral in reaction, containing 0.76% organic carbon, low available nitrogen (248.9 kg ha^{-1}), medium phosphorus (21.79 kg ha^{-1}), and medium potassium (370.77 kg ha^{-1}). The recommended fertilizer doses for the respective crops were: 120:60:40 kg N: P_2O_5:K_2O ha^{-1} for sweet corn, 25:60:30 for French bean, 150:85:75 for cabbage, and 150:100:75 for tomato. Organic nutrient sources such as FYM, neem cake, and vermicompost were applied on the basis of nitrogen content prior to sowing/transplanting, while the phosphorus requirement was met through rock phosphate (22% P_2O_5), after accounting for the P supplied from manures. Jeevamrit was applied along with irrigation water as part of natural farming treatments. Inorganic sources of nutrients, namely urea, single superphosphate, and muriate of potash, were applied treatment-wise in furrows at the time of sowing/transplanting. All rabi crops were sown or transplanted on 4 November 2020

The results revealed that, during the rabi season, the nutrient concentration in grain, fruit, head, and stover was not significantly influenced by different nutrient management practices. However, the maximum nutrient uptake by plants was recorded under the treatment receiving 100% inorganic fertilizers supplemented with 5 t FYM ha^{-1}, whereas the lowest nutrient uptake was observed under the treatment with 25% nutrients supplied through organic sources + 25% through inorganic sources along with natural farming (NF).
***Keywords* :** Soybean, moong, NPK, yield, uptake, concentration

Introduction

Soybean (*Glycine max* L. Merrill) ranks as the second most important oilseed crop after groundnut. It is often called the “gold of the 20th century” because of its easy cultivation, high benefit–cost ratio, and low nitrogen requirement. Being a legume, soybean can fix atmospheric nitrogen and has a deep root system that improves soil health. Its seeds are highly nutritious, containing about 40% protein, 18–20% oil, 26% carbohydrates, 2% phospholipids, and 4% minerals (Haldankar *et al*., 1992).

In Central India, particularly in Vertisols and related soils, the major cropping patterns are soybean–wheat and soybean–chickpea. Soybean is mostly grown under rainfed conditions, while wheat and chickpea perform better under irrigated systems. The soybean–chickpea sequence is common in areas with limited rainfall or scarce irrigation facilities. However, continuous cultivation of these systems has created several challenges, including nutrient depletion, high input requirements, difficult weed management, soil deterioration, delayed sowing of wheat, and low returns due to poor productivity and weak market prices. Moreover, the soybean–chickpea system is more vulnerable to pest and disease problems since both crops belong to the same family.

These traditional systems also fail to meet the complete domestic needs of farmers for vegetables, edible oils, fruits, and pulses. Because soybean and wheat fetch comparatively lower market prices than high-value crops, farmers' purchasing capacity and household nutrition remain constrained. Diversifying the existing systems by introducing high-value rabi crops could therefore improve profitability, productivity, and resource use efficiency, while safeguarding soil health and the environment.

Hence, there is a need to evaluate diversified soybean-based cropping systems under current agro-ecological and socio-economic conditions. Inclusion of crops like cabbage, tomato, French bean, and sweet corn during rabi offers promising alternatives. Such diversification not only raises farm income but also ensures sustainable production, environmental conservation, and fulfilment of food, nutrition, and fodder demands. Studying soybean-based systems in combination with nutrient management practices is thus essential to understand their cumulative effects on succeeding crops and long-term system sustainability.

Material and Method

An experiment was performed in the rabi season of 2021-22 at Instructional cum Research Farm at of IGKV, Zora, Labhandi, Raipur (Chhattisgarh). The experimental data were statistically analyzed using the OPSTAT statistical software developed by CCSHAU, Hisar. Analysis of variance (ANOVA) was performed as per the procedure of Gomez and Gomez (1984), and treatment means were compared at the 5% level of significance. The climate of the region is dry moist to sub humid. The soil of the experimental field was vertisols with low, medium and medium in N, P and K, respectively and neutral in reaction The experiment was layout in strip plot Design having three replication and six treatments viz, NM_1 : 100% organic NM_2 : 50% organic + NF (Natural Farming) NM_3 : 50% organic + 50% inorganic, NM_4 : 25% nutrient through organic + 25% nutrient through inorganic source + NF (Natural Farming), NM_5 : 100% inorganic, NM_6 : 100% inorganic + 5 t FYM ha^{-1} and four soybean based cropping system CS_1 : Sweet corn, CS_2 : French bean, CS_3 : Cabbage, CS_4 : Tomato. Crops were transplanted/sown on 4.11.20 for almost all the crops.

Result and Discussion

Nitrogen, phosphorus and potassium concentration (%) in the grain and stover of maize

Table 1 shows the information on how different nutrient management strategies affect the amounts of nitrogen, phosphorous, and potassium in maize grain and stover. It was discovered that the differences in grain and stover caused by various nutrient management strategies were not statistically significant.

Total Nitrogen, phosphorus and potassium uptake (kg ha^{-1}) in the grain and stover of sweet corn

Figure 1 shows the data on how different nutrient management strategies affect sweet corn's uptake of N, P, and K in the cob, stover, and total. The application of 100% inorganic + 5 t FYM ha^{-1} (NM6), followed by 100% organic (NM1), resulted in the highest nutrient uptake of grain and stover. Conversely, the delivery of 25% nutrients through organic +25% through inorganic +NF (NM4) resulted in the lowest nutrient uptake of grain and stover.

Proteins that store nitrogen or that are engaged in a variety of biological processes use nitrogen as a structural element. The rise in dry matter production and content was likewise linked to the increase in absorption caused by N. increased uptake of phosphorus, primarily as a result of organic acids generated during compost decomposition converting fixed phosphorus into a form that is easily accessible. The increased intake of nitrogen, phosphate, and potassium may be the consequence of balanced and sufficient nutrient availability in the soil, which led to enhanced dry matter production as indicated by the plant's increased fresh and dry weight. These findings support those of Devi *et al.* (2018), Datta *et al.* (2003), and Nanjapp *et al.* (2001).

Table 1 : Effect of various nutrient management practices on N, P and K concentration (%) of grain and stover of sweet corn.

Nutrient concentration (%) on grain and straw of sweet corn						
Nutrient management	N		P		K	
	Grain	Stover	Grain	Stover	Grain	Stover
NM_1 : 100% Organic	1.56	0.59	0.53	0.38	0.89	1.55
NM_2 : 50% Organic + NF	1.54	0.55	0.48	0.31	0.81	1.48
NM_3 : 50% Organic + 50% Inorganic	1.52	0.57	0.51	0.37	0.82	1.51
NM_4 : 25% Nutrient through organic and 25% nutrient through inorganic + NF	1.49	0.56	0.49	0.34	0.20	1.49
NM_5 : 100% Inorganic	1.57	0.68	0.50	0.36	0.85	1.52
NM_6 : 100% Inorganic + 5 t FYM ha^{-1}	1.69	0.61	0.55	0.39	0.90	1.58
SEm ±	0.003	0.030	0.011	0.022	0.029	0.029
CD (P=0.05)	NS	NS	NS	NS	NS	NS

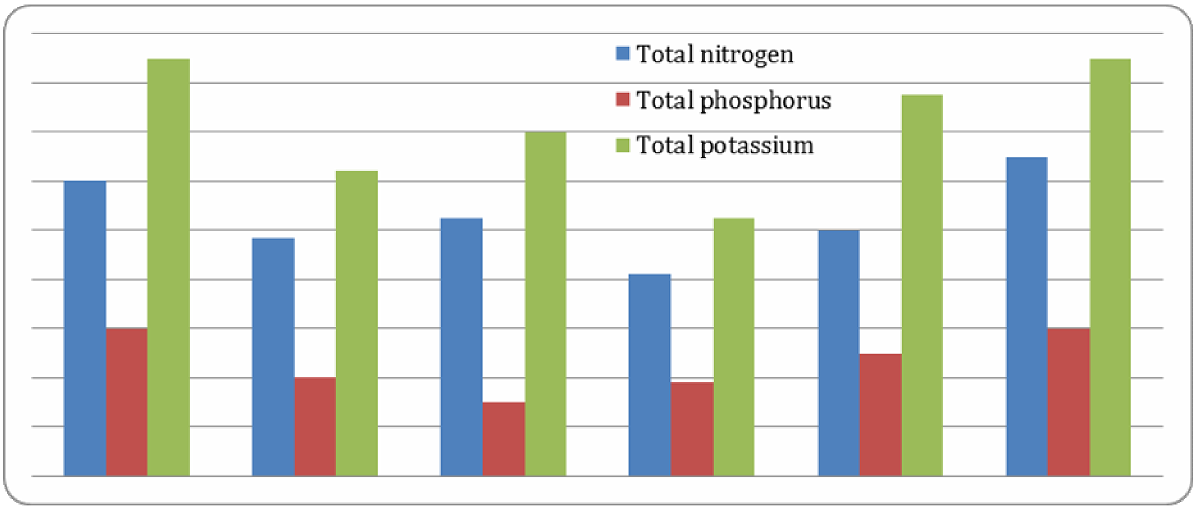

Fig. 1 : Effect of various nutrient management practices on N, P and K uptake (Kg ha^{-1}) of grain and stover of sweet corn

Nitrogen, phosphorus and potassium concentration (%) in the grain and stover of Moong bean

The data in relation to concentration of nitrogen, phosphorus and potassium in the grain and stover of moong bean as influenced by various nutrient management techniques is presented in Table 2. It was found that the difference made due to several nutrient management techniques was non-significant in grain and stover.

Total Nitrogen, phosphorus and potassium uptake (kg ha^{-1}) in the grain and stover of moong bean

Figure 2 shows the data about moong bean uptake of N, P, and K in the cob, stover, and total as influenced by different nutrient management approaches. The application of 100% inorganic + 5 t FYM ha^{-1} (NM6) resulted in the highest nutrient uptake of grain and stover; in contrast, the application of 25% organic + 25% inorganic +NF (NM4) resulted in the lowest nutrient uptake of grain and stover. Higher rates of fertilization led to a large increase in nitrogen uptake, which was caused by luxuriant crop growth, high dry matter production, yield, and yield characteristics.

The results are in agreement with the finding of Shubhashree *et al.*, (2011), Dalai *et al.*, (2019), Shiragavi *et al.*, (2018), Veeresh *et al.*, (2003) in French bean.

Table 2 : Effect of various nutrient management practices on N, P and K concentration (%) of grain and stover of moong bean.

Nutrient concentration (%)						
Nutrient management	**N**		**P**		**K**	
	Grain	**Stover**	**Grain**	**Stover**	**Grain**	**Stover**
NM_1 : 100% Organic	4.53	0.82	0.65	0.34	1.19	1.26
NM_2 : 50% Organic + NF	4.44	0.73	0.60	0.31	1.11	1.21
NM_3 : 50% Organic + 50% Inorganic	4.45	0.85	0.61	0.33	1.12	1.24
NM_4 : 25% Nutrient through organic and 25% nutrient through inorganic + NF	4.44	0.71	0.59	0.30	1.10	1.13
NM_5 : 100% Inorganic	4.48	0.89	0.63	0.31	1.15	1.22
NM_6 : 100% Inorganic + 5 t FYM ha^{-1}	4.54	0.84	0.66	0.35	1.21	1.27
SEm ±	0.038	0.032	0.024	0.026	0.029	0.032
CD (P=0.05)	NS	NS	NS	NS	NS	NS

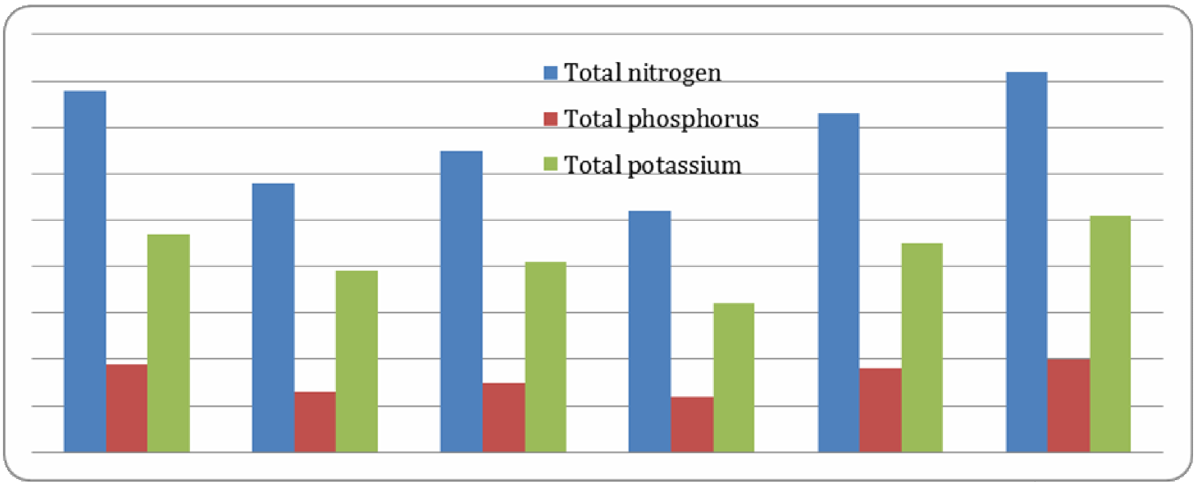

Fig. 2 : Effect of various nutrient management practices on N, P and K uptake (kg ha^{-1}) of grain and stover of moong bean

Nitrogen, phosphorus and potassium concentration (%) in the head and stover of Cole crop (Cabbage)

The data in relation to concentration of nitrogen, phosphorus and potassium in the head and stover of cabbage as influenced by various nutrient management techniques is presented in Table 3. It was found that the difference made due to several nutrient management techniques was non-significant in fruit and stover.

Total Nitrogen, phosphorus and potassium uptake (kg ha^{-1}) in the head and Stover of Cabbage

The data in relation to uptake of nutrient in the head, Stover and total by cabbage as influenced by various nutrient management techniques is presented in Figure 3. The maximum nutrient uptake of head and Stover was recorded under the application of 100% inorganic + 5 t FYM ha^{-1} (NM_6), On the contrary, the minimum nutrient uptake of head and Stover was recorded under the application of 25% nutrients through organic +25% nutrients through inorganic +NF (NM_4).

The total uptake of N, P and K by cabbage increased with increasing fertilizer doses. The significant increase in N, P and K uptake by cabbage with the increasing levels of fertigation was due to the effect of higher yield along with higher N, P and K content in head. The content and uptake of any nutrient in the plant is directly related to the availability in the feeding zone and growth of plant. Thus, increasing in the dose of N, P and K might have resulted in higher content and uptake of these nutrients in cabbage. The probable explanation of this result is better utilization of N, P and K with increased rate of fertigation levels and frequency of application. The higher availability of nutrients boosted the vegetative growth, increased photosynthesis and longer roots to absorb nutrients efficiently resulted in higher nutrient uptake. These results are in agreement with those reported by

Chingak *et al.,* (2018), and Singh *et al.,* (2010) Sharma and Sharma (2002).

Table 3 : Effect of various nutrient management practices on N, P and K concentration (%) of head and Stover of Cole crop

Nutrient concentration (%)						
Nutrient management	**N**		**P**		**K**	
	Grain	**Stover**	**Grain**	**Stover**	**Grain**	**Stover**
NM_1 : 100% Organic	2.26	0.74	0.42	0.19	3.67	4.66
NM_2 : 50% Organic + NF	2.24	0.59	0.28	0.12	23.3	3.03
NM_3 : 50% Organic + 50% Inorganic	2.25	0.60	0.40	0.14	3.70	3.13
NM_4 : 25% Nutrient through organic and 25% nutrient through inorganic +NF	2.21	0.52	0.41	0.08	3.41	2.47
NM_5 : 100% Inorganic	2.26	0.62	0.39	0.15	3.52	4.33
NM_6 : 100% Inorganic + 5 t FYM ha^{-1}	2.28	0.77	0.43	0.31	3.72	4.95
SEm ±	0.039	0.016	0.022	0.011	0.97	0.017
CD (P=0.05)	NS	NS	NS	NS	NS	NS

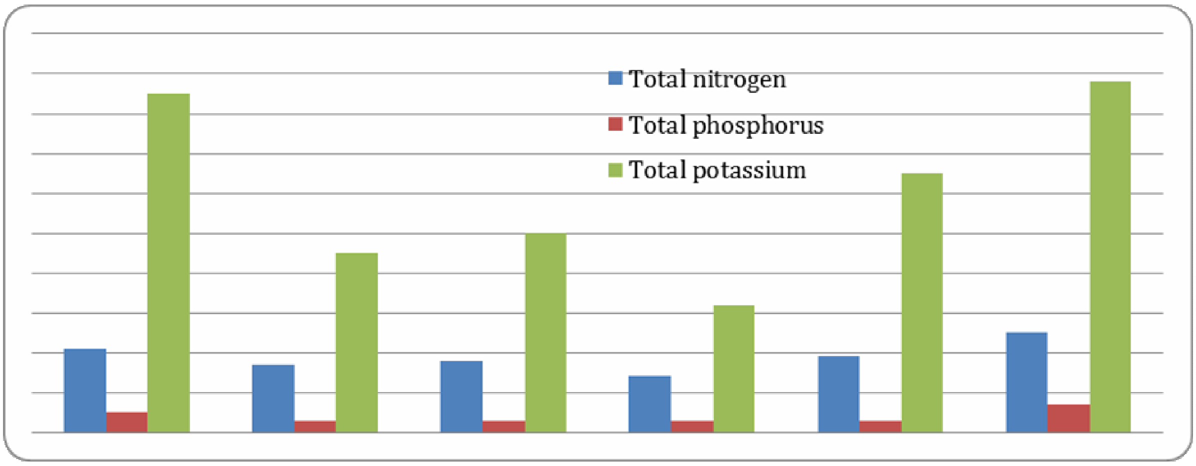

Fig. 3 : Effect of various nutrient management practices on N, P and K uptake (kg ha^{-1}) of head and stover of Cabbage

Nitrogen, phosphorus and potassium concentration (%) in the fruit and Stover of Tomato

The data in relation to concentration of nitrogen, phosphorus and potassium in the fruit and Stover of Tomato as influenced by various nutrient management techniques is presented in Table 4. It was found that the difference made due to several nutrient management techniques was non-significant in fruit and Stover.

Total Nitrogen, phosphorus and potassium uptake (kg ha^{-1}) in the fruit and Stover of Tomato

The data in relation to uptake of nutrient in the fruit, Stover and total by Tomato as influenced by various nutrient management techniques is presented in Figure 4. The maximum nutrient uptake of fruit and Stover was recorded under the application of 100% inorganic + 5 t FYM ha^{-1} (NM_6), On the contrary, the minimum nutrient uptake of fruit and Stover was recorded under the application of 25% nutrients through organic +25% nutrients through inorganic +NF (NM_4).

Higher dry matter production might have laid to higher uptake of nitrogen and in general when the uptake of nitrogen is more, the crop would have tendency to absorb more phosphorus and potassium. The built up of vigorous growth and higher photosynthetic rate might have laid to better uptake of nutrients by the crop similar finding of Pillai *et al.* (2019), Rajawat *et al.* (2019), Gorkhed *et al.* (2015).

Table 4 : Effect of various nutrient management practices on N, P and K concentration (%) of fruit and Stover of tomato

Nutrient concentration (%)						
Nutrient management	**N**		**P**		**K**	
	Grain	**Stover**	**Grain**	**Stover**	**Grain**	**Stover**
NM_1 : 100% Organic	1.31	0.59	0.53	0.31	0.68	3.27
NM_2 : 50% Organic + NF	1.28	0.67	0.49	0.54	0.56	3.41
NM_3 : 50% Organic + 50% Inorganic	1.30	0.74	0.49	0.47	0.63	3.01
NM_4 : 25% Nutrient through organic and 25% nutrient through inorganic + NF	1.28	0.60	0.47	0.21	0.51	3.06
NM_5 : 100% Inorganic	1.30	0.52	0.51	0.21	0.64	3.18
NM_6 : 100% Inorganic + 5 t FYM ha^{-1}	1.33	0.78	0.21	0.54	0.71	3.45
SEm ±	0.021	0.011	0.027	0.014	0.058	0.021
CD (P=0.05)	NS	NS	NS	NS	NS	NS

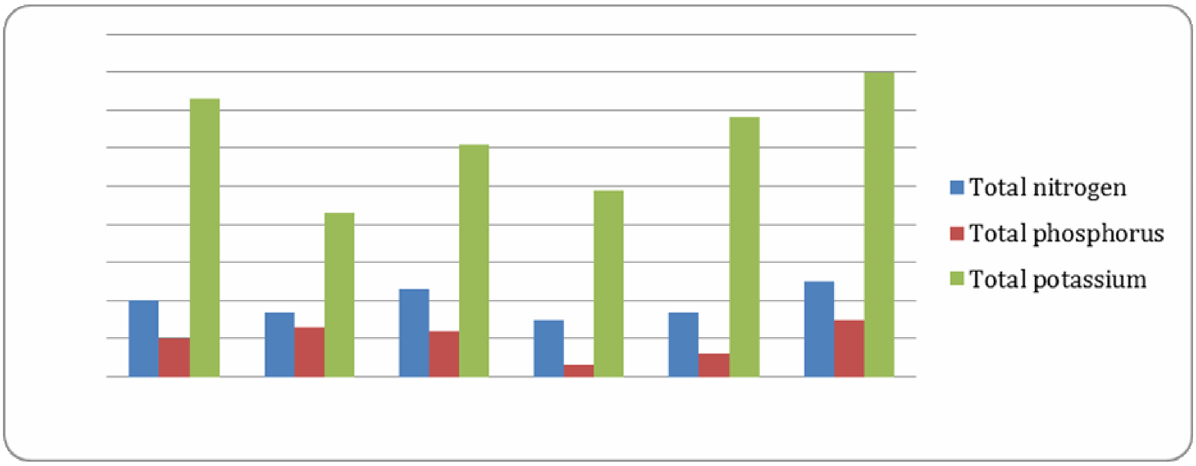

Fig. 4 : Effect of various nutrient management practices on N, P and K uptake (kg ha^{-1}) of fruit and Stover of tomato

Conclusion

Nutrient concentration of N, P and K was not significantly affected due to various nutrient management techniques in all the rabi crops. Total uptake of nutrients in plant was significantly higher in the application of 100% inorganic +5 t FYM ha^{-1}. Which is followed by 100% Organic and 50% Organic + 50% Inorganic whereas, lower nutrient uptake in plant was observed under the application of 50% Organic + NF.

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