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Nutrient management in soybean (*Glycine max*)-mustard (*Brassica juncea*) crop sequence

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ABSTRACT

An experiment was conducted at Morena during 1993-94 and 1994-95 to study the effect of organic and inorganic sources of plant nutrients on productivity, nutrient uptake and economics of soybean [*Glycine max* (L.) Merr.]-mustard [*Brassica juncea* (L.) Czernj & Cosson] cropping sequence. Significantly higher seed yield of soybean was recorded with N_{40} (½ B + ½ T) $P_{80}K_{20}$ (20 kg N applied as basal and rest 20 kg N top dressed at 30 DAS), whereas in mustard the yield was highest when N_{40} (½ + ½) $P_{80}K_{20}$ (20 kg N supplied through FYM and remaining 20 kg N through urea) was applied in soybean. The maximum mean total land productivity and net return were obtained from N_{40} (½ + ½) $P_{80}K_{20}$. The uptake of NPK was maximum when soybean was fertilized with N_{40}(½ + ½) $P_{80}K_{20}$, whereas in mustard maximum uptake of NPK was recorded with N_{40} (½ + ½) P_{80} K_{20} was given to soybean crop in *kharif.*

Key words : Land productivity, NPK uptake, Economics, Soybean-mustard crop sequence

Due to higher profitability the fallow-mustard system is the prominent cropping system in northern pocket (Morena and Bhind districts) of Madhya Pradesh, which is the major mustard growing area. The cropping intensity is only 123%. Under double cropping, soybean-mustard system is fast emerging as a better remunerative alternative. Nutrient management plays a key role in augmenting the oilseed productivity. Nutrient present in organic matter are not fully available to the crops in the season of its application. Less than 30% N and a small fraction of P and not more than 1 half of K may become available to the immediate crop and rest of nutrients may be partly utilized by the subsequent crops (Gaur 1982). Hence keeping in view the above facts, the present investigation was under taken to evolve an integrated nutrient management approach

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considering the requirement of the system as a whole.

MATERIALS AND METHODS

The present study was carried out at Zonal Agricultural Research Station, Morena, during *kharif* as well as *rabi* seasons of 1993-94 and 1994-95. The soils of the experimental site was sandy loam with pH 7.1, organic carbon 0.21% and available, N, P_2O_5 and K_2O were 225.0, 3.40 and 334.8 kg/ha respectively. The experiment was laid down in randomized block design with 4 replications. The treatments consisted of applying different levels of inorganic fertilizers either alone or in combination with organic manure in various proportions to *kharif* soybean and only inorganic fertilizers at recommended dose to the succeeding *rabi* mustard as per detail given here : T_1-Absolute control (No fertilizer); T_2-N_{20} $P_{40}K_{20}$ kg/ha ; T_3-N_{20} $P_{60}K_{20}$ kg/ha; T_4-N_{20} P_{80} K_{20} kg/ha; T_5-N_{40} P_{40} K_{20} kg/ha; T_6-N_{40} P_{60} K_{20} kg/ha; T_7-N_{40} P_{80} K_{20} kg/ha; T_8-N_{40} (½ N through urea + ½ N through FYM) P_{40} K_{20} kg/ha; T_9-N_{40} (½ N through urea + ½N through FYM) P_{60} K_{20} kg/ha; T_{10}-N_{40} (½ N through urea + ½ N through FYM) P_{80} K_{20} kg/ha; T_{11}- N_{40} P_0 K_0 kg/ha; T_{12}-N_{40} (½ N basal + ½ N top dressed) P_{80} K_{20} kg/ha.

The nitrogen in treatment N_{40} P_{80} K_{20} kg/ha was applied in 2 splits, i.e. 50% as basal at the time of sowing and 50% top dressed at 30 days after sowing. The organic manure supplied through FYM while fertilizer nutrients were applied through urea, single superphosphate and muriate of potash to soybean. In *rabi* season, mustard crop received recommended dose 80 : 40 : 20 kg NPK/ha of inorganic. The full dose of P_2O_5 and K_2O was drilled as basal along with 40 kg N and remaining 40 kg N/ha was top-dressed at 35 DAS. The cultivar 'JS 71-05' of soybean and 'Pusa Bold' of Indian mustard were sown 30 cm apart during respective *kharif* and *rabi* seasons. The soybean crop was irrigated once at the time of maturity and mustard was irrigated twice, first at 30 DAS and second at 65 DAS. N content of grain and straw was determined by Kjeldhal's method, while N uptake was calculated using dry matter production and N content of the respective components.

RESULTS AND DISCUSSION

Soybean yield

The grain yield of soybean increased linearly upto higher dose of fertility level (Table 1). Application of nitrogen alone @ 40 kg/ha did not influence soybean yield significantly over the control. Increasing levels of P up to 80 kg/ha either with $N_{20}K_{20}$ or $N_{40}K_{20}$ brought about significant improvement in yield over its preceeding levels. Since P is important in the development of plant roots and in increasing the number and size of grain the response was expected. A positive response of P has also been noted by Rajput *et al.* (1991) and Gupta *et al.* (1992). The highest average yield of 1,791 kg/ha was observed under N_{40} (½ B + ½T) $P_{80}K_{20}$ which was at par with N_{40} (½ + ½) P_{80} K_{20} and N_{40} P_{80} K_{20}but significantly superior to rest of the treatments. As the crop requires adequate nutrients for initial establishment, branching and yield attributes and thus resulted in higher yield under N_{40} (¼B + ½ T) P_{80} K_{20}. The higher yield was owing to the additive and complementary effect of yield attributing characters (Table 2). The

Table 1. Yield and yield attributes of soybean-mustard crop sequence as influenced by various treatments (average of 2 years)

Treatment	*Kharif* crop-Soybean					*Rabi* crop-Mustard				
	Pods/ plant (No.)	Pod weight/ plant (g)	Seed yield/ plant (g)	1,000-seed weight (g)	Seed yield (kg/ha)	Siliquae/ plant (No.)	Seeds/ siliqua (No.)	Seed yield/ plant (g)	1,000-seed weight/ (g)	Seed yield (kg/ha)
T_1	15.3	5.9	4.2	102.9	1,052	184	7.83	10.33	4.88	1,245
T_2	17.3	6.5	5.5	107.4	1,287	219	7.99	12.76	5.01	1,375
T_3	17.5	7.1	5.9	109.7	1,468	236	8.25	13.88	5.38	1,757
T_4	18.3	8.9	6.3	110.4	1,445	242	8.92	14.10	5.42	1,789
T_5	18.5	9.4	6.5	110.8	1,502	230	8.52	13.58	5.30	1,695
T_6	20.9	9.8	6.6	111.3	1,647	240	8.84	14.62	5.45	1,817
T_7	22.5	10.6	6.8	111.7	1,777	252	9.10	15.35	5.72	1,845
T_8	18.7	10.3	6.6	112.3	1,489	263	9.01	17.38	5.92	1,877
T_9	19.0	12.7	7.0	114.7	1,624	269	9.50	18.42	6.33	1,970
T_{10}	21.1	13.3	7.8	115.4	1,770	276	9.82	20.15	6.43	2,109
T_{11}	17.0	7.8	4.2	107.4	1142	199	7.88	10.50	4.91	1,286
T_{12}	25.6	14.4	7.9	115.5	1,791	266	9.79	20.01	6.40	1,989
CD (P = 0.05)	2.01	0.26	0.33	2.21	120	8	2.03	2.26	1.92	129

The treatment details are given in materials and methods

contribution in increasing the seed yield at N_{40} (½B + ½T) $P_{80}K_{20}$ was from the highest number of pods/plant (20.5), pods weight/plant (14.4), seed yield/plant (7.9) and 1,000-seed weight (115.9).

Mustard yield

The residual effect of different levels of fertility, applied to *kharif* soybean, on the *rabi* mustard showed significant variation in seed yield. The highest yield of 2,109 kg/ha was observed when N_{40} (½ + ½) $P_{80}K_{20}$ was applied to *kharif* soybean. This yield was at par with N_{40} (½B + ½T) $P_{80}K_{20}$ and significantly superior to rest of the treatments (Table 1). The higher values of yield attributes of mustard might be mitigated in the more uptake of nutrients with the use of organic manure in soybean. Organic manure helped in enrichment of the soil with nutrients and fixation of atmospheric N by preceeding crop (i.e. soybean) which led to the enhancement of grain yield of succeeding crop (i.e.mustard) significantly. Similar results have been reported by Tyagi and Rana (1992) and, Ramanurthy and Shivashankar (1996).

Total land productivity and economics

The total land productivity was found to be higher in treatments, where both *kharif* and *rabi* season crops received the highest fertility level, and recommended dose respectively. There was considerable reduction in the land productivity with reduction of the fertilizer levels to $N_{20}P_{40}K_{20}$ or $N_{40}P_{40}K_{20}$ to soybean. Maximum grain production of 3,836 kg/ha/year (average of 2 years) was

Table 2. Total land productivity and economics of soybean -mustard sequence as influenced by various treatments (average of 2 years)

Treatment	Total land productivity (kg/ha)	Gross returns (Rs/ha)	Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	Net returns over control (Rs/ha)	Net returns over control (%)	Benefit : cost ratio
T_1	2,227	23,356	10,337	13,019			1.26
T_2	2,662	26,796	11,137	15,859	2,840	21.8	1.42
T_3	3,225	32,828	11,397	21,431	8,412	64.6	1.88
T_4	3,334	33,828	11,557	22,171	9,152	70.3	1.90
T_5	3,197	32,356	11,277	21,079	8,060	61.9	1.86
T_6	3,464	34,980	11,537	23,443	10,424	80.0	2.03
T_7	3,615	36,300	11,797	24,503	11,484	88.2	2.07
T_8	3,375	34,180	11,174	23,006	9,987	76.7	2.06
T_9	3,594	36,200	11,434	24,766	11,747	90.2	2.17
T_{10}	3,886	39,524	11,694	27,830	14,811	113.8	2.38
T_{11}	2,428	24,568	10,477	14,891	1,872	14.8	1.42
T_{12}	3,780	38,196	11,797	26,399	13,380	102.8	2.24

Market values for soybean and mustard Rs 8 and Rs 12 kg respectively
For nitrogen, phosphorus, potash and FYM Rs 7, 13, 7 and 0.15/kg respectively

Table 3. N, P and K uptake (kg/ha) as influenced by various treatments (average of 2 years)

Treatment	Soybean			Mustard		
	N	P	K	N	P	K
T_1	69.0	8.6	46.4	108.8	22.8	50.0
T_2	76.8	10.0	49.7	116.7	23.6	53.7
T_3	78.4	11.3	52.8	127.0	30.5	62.1
T_4	81.5	11.8	54.0	137.0	31.8	63.9
T_5	80.6	11.2	53.4	126.7	30.4	61.2
T_6	85.6	12.8	55.7	134.2	32.1	64.4
T_7	89.6	14.0	57.9	136.8	32.2	65.4
T_8	83.2	10.8	51.9	140.7	32.7	66.4
T_9	79.0	12.3	55.0	152.7	33.8	69.2
T_{10}	93.3	13.5	58.6	154.7	36.6	75.0
T_{11}	71.8	9.1	47.3	113.0	25.1	54.3
T_{12}	96.0	14.9	59.1	148.2	34.8	68.1

obtained when N_{40} (½ + ½) $P_{80}K_{20}$ applied to soybean and recommended dose, i.e. $N_{80}P_{40}K_{20}$ to mustard. The results confirm the findings of Jana and Ghosh (1996). The land productivity value was also considerably high when *kharif* season crop (soybean) received N_{40} (½ + ½) $P_{80}K_{20}$ or $N_{40}P_{80}K_{20}$ along with recommended dose (i.e. $N_{80}P_{40}K_{20}$) application of NPK, during *rabi* season. The least total land productivity was observed in the control plot.

The highest net profit of Rs 27,830/ha from the total productivity was under N_{40} (½ + ½) $P_{80}K_{20}$ which gave maximum benefit: cost ratio (2.38).

N, P and K uptake

During *kharif* season, the highest uptake of N, P and K was recorded when 50% nitrogen was applied as basal and 50% nitrogen at 30 DAS. The maximum uptake of N, P and K may be ascribed to the improvement in nodulation due to top dressing of nitrogen. However, the uptake of N, P and K by the plants was considerably higher when 50% nitrogen was applied through organic source, i.e. FYM and remaining 50% nitrogen through inorganic source, i.e. urea. In such case the higher uptake of N, P and K nutrients could be due to proper and timely release of nutrients for uptake. The uptake of N, P and K was less when fertilizers were applied through inorganic source (Table 3). The reduction is likely to be due to greater losses of N through leaching, volatilization, or fixation in soil and /or due to less mineralization and release of soil nutrients. The plant uptake of N, P and K followed the pattern of grain yield.

During *rabi* season, maximum uptake of NPK nutrients was recorded, where mustard crop received recommended dose (80:40:20)

of fertilizers, preceeded by the treatment receiving 50% through inorganic source applied to *kharif* season crop (i.e. soybean). This could be due to residual effect of nutrients available through organic source and fixation of atmospheric N by soybean (Ramamurthy and Shivashankar, 1996).

It could be inferred that in sandy loam soils, the total land productivity and net return could be improved with application of fertilizers at N_{40} (½ + ½) P_{80} K_{20} along with recommended level of nutrients to succeeding crop. It is clear that for sustaining the productivity in soybean-mustard double cropping sequence a part of the total nutrients should be applied through organic source to preceeding crop (i.e. soybean).

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