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Effect of integrated nutrient management on productivity of Soybean-Linseed cropping system in Vertisol of Maharashtra

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Abstract
A field experiment was conducted on soybean-linseed cropping system during2010-11 to 2012-13 in Vertisol of Nagpur with the objective to increase the productivity of system and fertility of the soil. The treatment consisted of recommended dose of fertilizer(100% NP) to both the crops, INM(75% NP + Biofertilizers alone or in combination with 5 t ha^{-1} FYM in kharif) and sub-optimal applications of fertilizer alone or in combinations. Application of 100% NP (RDF) to both the crops recorded significantly higher linseed equivalent yield, GMR, NMR and B: C ratio and was closely followed by the treatment of 100% RDF to any one crop and 75% NP with combination of seed treatment of biofertilizers to other crop. Soil fertility status was increased due to use of integrated nutrient management of 75% NP + 5 t ha^{-1} FYM +Seed treatment of bio-fertilizers. Use of organic manures and biofertilizer reduced the dose of chemical fertilizers for increasing crop productivity and sustaining soil fertility.

Key Words: *Cropping system, Soybean, Linseed, INM, Vertisol*

Soybean –Linseed cropping system is predominant under rainfed area with residual soil moisture in Vertisols of central India. Both the crops are important for protein and oil production. Linseed is for medicinal purpose as it content high values of omega 3 and 6.Use of NPK fertilizers and with no use of organic manure by the farmers in this region result records Poor yields of crops as well as deterioration of soil fertility. Combined application of available organic resources along with optimal dose of inorganic fertilizers assures high and sustained productivity in a cropping system due to regulated nutrient supply and reduced losses, besides lowering cost (SubbaRao et al., 1998; Manna et at.,2003). Recommended dose of fertilizers produced higher yields, but to get optimum productivity and maintaining soil fertility the integrated nutrient management is more suitable because it reduces the application chemical besides being an environmental friendly approach (Ram and Mir, 2006). Long term fertilizer experiment indicated that application of fertilizer alone has a deleterious effect on soil health and crop productivity (Behera et al.,2007). The present investigation was taken up to study the effect of integrated nutrient management on productivity of soybean –linseed cropping system since limited information is available.

A field trial was conducted on Vertisol (Typic Haplustert) during the year 2010 to 2013 at the farm of AICRP on Linseed , College of Agriculture, Nagpur having semiarid and subtropical climate situated in 21o 10' N Latitude and 79o 19' E longitude and 312.2 m above mean sea level. Soil samples upto15 cm depth were taken before and after experiment for analysis of fertility status. 5 plants were selected randomly from net plot to record growth and yield attributing parameters. The soil of the experimental site was clayey, slightly alkaline in reaction, medium in organic carbon and available N, low in available P whereas high in available K. Soil available N, P_2O_5 and K_2O were analyzed through alkaline permanganate All the recommended practices were followed for growing Soybean in kharif and Linseed in rabi sequence. Inorganic fertilizer and organic manure were applied as per treatments. Soybean cultivar JS-335 and linseed cultivar NL-97 was used. Biofertilizers each @of 25 g per kg of seed was used for treatment. The field trial was designed in RBD with three replications consisted sixteen treatment for three years on same site with same randomization. The treatments were as mentioned below.

Treat. No.	Soybean (Kharif)	Linseed (Rabi)
T1	100 % NP (30:75:00) RDF	100 % NP (60:30:00) RDF
T2	100% NP	75% NP+ Azatobacter + PSB
T3	75% NP+ Rhizobium+PSB	100%NP
T4	75% NP+ Rhizobium+PSB	75% NP+ Azatobacter + PSB
T5	75% NP	75% NP
T6	75% NP+5 t FYM	75% NP
T7	75% NP + 5 t FYM +Rhizobium + PSB	75 % NP+ Azatobacter + PSB

T8	75% NP + 5 t FYM +Rhizobium + PSB	50 % NP+ Azatobacter + PSB
T9	75% NP + 3 t FYM +Rhizobium + PSB	75 % NP+ Azatobacter + PSB
T10	75% NP + 3 t FYM +Rhizobium + PSB	50 % NP+ Azatobacter + PSB
T11	50% NP + 5 t FYM +Rhizobium + PSB	50 % NP+ Azatobacter + PSB
T12	50% NP + 5 t FYM +Rhizobium + PSB	50 % NP
T13	50% NP = Rhizobium + PSB	50 % NP
T14	100 % NP	No NP
T15	No NP	100 % NP
T16	No NP	No NP

RESULTS AND DISCUSSION

Results indicated that growth as well as yield attributing characters were influenced due to treatments (Table 1) . Highest plant height was recorded in T1 (100% NP to both the crops) and on par with other INM treatments (From T2 to T12 and T14). Number of pods per plant of soybean recorded higher in T1,T2 and T14 (100 % NP) followed by T3 (75% NP+ Rhizobium+PSB) and T7(75% NP + 5 t FYM/ha + rhizobium + PSB) which were at par. 100 seed weight were found at par in 100 % NP and 75% NP+ bio-fertilizers seed treatment and 5 t FYM/ha combinations. Similar results were also observed regarding yield attributes of linseed. Plant height ,number of capsules per pant and 100 seed weight was significantly high in 100% NP treatment , however the treatments with azotobacter and PSB (T2,T4,T7 and T9) were at par.

The yield data of Soybean and Linseed was recorded for three years and depicted in table 2. Amongst the three year the crop yield was lower in the year 2011-12 due to occurrence of dry spell in the month of September. However, the effect of treatments was observed similar. Significantly higher yield obtained with 100% NP to both the crops (T1) which was at par with the treatment of 75%NP in combination with bio-fertilizer and 5 t FYM/ha in kharif season. Oil seed crops responded to NPK fertilizers (Tripathi et al. 1998; Sharma and Dayal 2005).

Data of the three years pooled mean (Table 3) indicated that 100% NP treatments (T1and T2) gave the 95 to 97 per cent more soybean yield than the control (T16) .The INM treatments with reduced dose of NP (T3, T4, T6, T7, T8) gave the 81 to 86 percent yield over control (T16) whereas suboptimal applications gave significantly less increase over control.

The linseed yield was increased from 71 to 77 percent over the control due to application of 100% NP (T1 and T3) and the INM treatments gave 55 to 68 percent increase over the control treatment. However the suboptimal applications showed significantly lower percent increase in yield over the control.

The linseed equivalent yield was highest under 100 % NP to both the crops and it was found increased by 86.9 % over the control. The INM treatments with 25% reduced dose of NP were also observed increased (66.8 to 77.9%) over the control, whereas suboptimal doses reduced the linseed equivalent yield.

Economics of Soybean – Linseed system as influenced by INM treatments (Table-4) showed that highest gross monitory returns was recorded in T1 (100%NP to both the crops) which was at par with treatmentsT2,T3,T4and T6 and gave significantly more over control.Net monitory returns was significantly high in T1and the treatments T2, T3 and T4were at par with each other. The lower NMR in INM treatments might be attributed to decreased yields due to less availability of nutrients. Hegde and Babu (2004) observed that profitable oilseeds cultivation is possible with integrated use of nutrient sources to improve the productivity. The cost of cultivation was increased in the FYM treatments which caused reduction in net monitory returns. The benefit/cost ratio was highest (2.72) in 100% NP to both the crops(T1) whereas the treatments with 75% NP and biofertilizers(T2,T3 & T4) have nearer B: C ratio.

After completion of three cycles of soybean- linseed cropping sequence, integrated nutrient management (75%NP to both the crops + 5 t FYM In kharif + seed treatment of biofertilizer to both the crops) improved available nitrogen (280.6 kg ha^{-1}) and potassium(450.8 kg ha^{-1}) status in soil after experiment over their initial status, whereas the available P status remains almost similar in inorganic and INM treatment (Table 5). Similar beneficial effect of organic manure were reported by several workers in soybean based cropping systems (Shivakumar and Ahlawat,2008; Ramesh et al. 2009). The status of NPK in soils remains correspondingly lower sides with the suboptimal applications of fertilizers and manure. These results are in close agreement with the findings of Patel et al. (1995).

Conclusion

In soybean- Linseed copping system application of 100% NP (RDF) to both the crops recorded significantly higher linseed equivalent yield, GMR, NMR and B:C ratio and was closely followed by 75% NP in combination with seed treatment of biofertilizers. Soil fertility status was increased due to use of integrated nutrient management with 25% reduction in fertilizer dose. Suboptimal applications reduced the productivity of system.

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Table 1. Yield attributes of soybean and linseed as influenced by INM

Treatments	Soybean (Pooled mean 2010-2013)			Linseed (Pooled mean 2010-2013)		
	Plant Height cm)	No. pods/ plant	100 seed wt. (g)	Plant Height cm)	No. capsules/ plant	100 seed wt. (g)
T1	62.3	44.9	10.9	71.1	39.0	7.5
T2	61.8	43.2	10.8	69.7	37.5	7.3
T3	60.4	41.9	10.5	70.7	37.6	7.5
T4	60.3	41.4	10.5	69.5	36.0	7.3
T5	58.7	39.4	10.3	68.5	32.3	7.2
T6	60.6	42.1	10.5	68.4	31.0	7.2
T7	61.2	41.6	10.8	69.9	35.2	7.3
T8	60.7	41.0	10.6	66.7	32.4	7.3
T9	59.4	39.8	10.4	69.3	32.2	7.2
T10	59.5	37.6	10.4	66.0	30.6	7.3
T11	58.4	30.9	10.2	66.2	30.6	7.3
T12	58.5	30.9	10.2	63.7	27.0	7.1
T13	57.6	29.7	10.2	63.6	27.6	7.1
T14	61.4	42.2	10.6	61.6	19.2	6.8
T15	51.9	24.7	9.7	65.2	37.0	7.4
T16	50.0	23.0	9.3	59.9	19.0	6.6
SE (m).$^{+}$	1.66	1.11	0.15	0.82	0.31	0.07
C.D.(5%)	4.03	3.20	0.44	2.35	0.91	0.21

Table2. Yield data of Soybean and Linseed as influenced by INM

Treatments	Soybean (kg ha-1)			Linseed (kg ha-1)		
	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13
T1	1395	1302	1509	945	910	1037
T2	1394	1280	1495	884	860	979
T3	1355	1192	1392	922	875	992
T4	1340	1170	1383	884	870	990
T5	1297	1145	1265	865	853	860
T6	1335	1165	1370	903	842	965
T7	1360	1205	1402	845	825	1002
T8	1350	1200	1383	784	730	840
T9	1315	1160	1352	780	767	987
T10	1320	1140	1337	788	776	860
T11	1250	1092	1297	765	760	832
T12	1265	1070	1292	760	740	774
T13	1077	810	1122	745	715	760
T14	1367	1190	1449	610	610	560
T15	865	610	742	905	852	940
T16	855	590	688	580	508	540
SE(m)	60	85	78.3	38	59.5	57.5
C.D.(5%)	175	241.6	226	115	171.5	166
CV	9.0	13.7	10.6	8.2	13.2	11.5

Table3. Linseed equivalent Yield (pooled mean) as influenced by INM

Treatments	Soybean kg ha^{-1}	% increase over control	Linseed kg ha^{-1}	% increase over control	Linseed equivalent kg ha^{-1}	% increase over control
T1	1402	97.2	964	77.5	1845	86.9
T2	1390	95.5	908	67.2	1787	81.1
T3	1313	84.7	930	71.3	1756	77.9
T4	1298	82.6	915	68.5	1730	75.3
T5	1236	73.8	859	58.2	1635	65.7
T6	1290	81.4	903	66.3	1714	73.7
T7	1322	85.9	891	64.1	1736	75.9
T8	1311	84.4	785	44.6	1610	63.1
T9	1276	97.5	845	55.6	1646	66.8
T10	1266	78.1	808	48.8	1603	62.4
T11	1213	70.6	786	44.7	1548	56.8
T12	1209	70.0	758	39.6	1517	53.7
T13	1003	41.1	740	36.3	1371	38.9
T14	1335	90.6	593	9.2	1444	46.3
T15	739	3.9	899	65.6	1366	38.4
T16	711	-	543	-	987	-
SE(m)	79.17	-	50.9	-	72.8	-
C.D.(5%)	228.5	-	148.5	-	213.0	-

Table 4. Economics (Rs. ha^{-1}) of Soybean-Linseed as influenced by INM

Treatments	Gross monitory returns	Cost of cultivation	Net monitory Returns	Benefit : Cost Ratio
T1	74656	27382	47274	2.72
T2	71963	27209	44754	2.64
T3	70891	27117	43774	2.61
T4	69961	26656	43305	2.61
T5	65850	26272	39578	2.50
T6	69288	40818	28470	1.70
T7	68665	41702	26963	1.64
T8	65102	40905	24197	1.59
T9	66694	36168	30526	1.84
T10	64834	38888	25946	2.07
T11	62590	40453	22137	1.54
T12	61328	40013	21315	1.53
T13	55331	25280	30051	2.18
T14	58271	25070	33201	2.32
T15	54530	23565	30965	2.31
T16	39736	21172	18564	1.88
SE(m)	1983	-	1983	-
C.D.(5%)	5725	-	5725	-

Table.5. Nutrient status of soil as influenced by INM after three cycles of Soybean-Linseed sequence

Treatments	Available N kg ha^{-1}	Available P_2O_5 kg ha^{-1}	Available K_2O kg ha^{-1}
T1	260.3	31.6	418.0
T2	254.2	30.2	396.8
T3	251.2	28.1	410.2
T4	240.2	26.1	412.8
T5	238.5	25.6	406.2
T6	244.3	29.4	424.8
T7	280.6	30.5	450.8
T8	268.5	28.3	442.6
T9	264.3	29.1	440.2
T10	260.1	28.3	432.3
T11	236.2	25.1	410.5
T12	238.4	23.0	402.4
T13	234.2	19.8	382.6
T14	231.5	21.3	392.8
T15	234.1	18.9	360.2
T16	208.6	16.1	352.6
Initial status	243.0	20.52	380.0