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Effect of nutrient and weed management on yield, nutrient uptake and quality of soybean [*Glycine max* (L.) Merrill] in alluvial soil of Bihar

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Abstract
A field experiment was conducted at Tirhut College of Agriculture, farm Dholi, Muzaffarpur, Bihar during *kharif* season 2016, to evaluate the effect of nutrient and weed management practices on yield, nutrient uptake and quality of soybean [*Glycine max* (L.) Merrill]. The experiment was laid out in split-plot design comprising of five nutrient levels in main plot and four in weed management practices in subplots with three replications. Maximum grain yield (16.94 q/ha) and total uptake of N (140.39 Kg/ha), P (9.11 Kg/ha) and K (50.53 Kg/ha) was noticed with 50% RDF along with 2.5 t FYM/ha and Vermicompost 1.25 t/ha which was significantly superior over control but statistically at par with 50% RDF + 5 t FYM/ha. In weed management practices, maximum yield (16.71 q/ha) and total uptake of N (136.92 Kg/ha), P (9.15 Kg/ha) and K (49.84 Kg/ha) was noticed with hand weeding twice at 25 and 45 DAS which was significantly superior over control but was at par with Pendimethalin 1.0 kg/ha (Pre-emergance) + one hand weeding at 40 DAS and Pendimethalin 1.0 kg/ha (Pre-emergance) + Imazethapyr 55 g/ha (Post-emergance) at 25 DAS. Protein content was not significantly affected due to different nutrient and weed management practices however maximum protein content was found with RDF (36.11%) and Pendimethalin 1.0 kg/ha (Pre-emergance) + Imazethapyr 55 g/ha (Post-emergance) at 25 DAS (36.04 %).

Keywords: FYM, quality, nutrients, weed, soybean and vermicompost

Introduction
Soybean [*Glycine max* (L.) Merr.] is also known as golden/miracle/wonder bean crop because it contains 38-42% good quality protein, 18-20% oil, rich in polyunsaturated fatty acids, good amount of minerals (Ca, P, Mg, Fe and K) and vitamins especially B-complex and tocopherols. It provides high amounts of phyto-chemicals and good quality dietary fiber which enables to protect human body against cancers and diabetes (Chouhan, 2007) [3].

It plays a pivotal role in meeting the continuously increasing demand of the edible oil across the world; it contributes 25% in total edible oil production. It is the world's most inexpensive source of high quality protein and also provides high quality oil. Nutrient management an important aspect has a significance in augmenting its production. Soybean is considered to be highly exhaustive crop, hence inadequate fertilization is also one of the major factors for its low productivity. Inadequate fertilizer use and emergence of multiple-nutrient deficiencies due to poor recycling of organic resources and unbalanced use of fertilizers are important factors to be considered for low productivity of soybean (Chaturvedi *et al*., 2010) [2]. It is an established fact that amongst nutrients, combination of an inorganic and organic nutrient sources are considered to be the most important for exploiting genetic potential of this crop. Next to nutrient management, weed infestation in soybean is one of the main constraints which limits the crop yield because it is a rainy season crop and it faces severe crop weed competition during active phase of growth. Yield reductions in soybean due to poor weed management ranges from 12 to 85% depending on weed flora and their density (Nagaraju and Kumar, 2009) [7]. Although weeds pose problems during the entire crop period but maintaining weed free condition during critical period (first 45 days after sowing) is very much essential (Hosmath, 2014) [5].

Therefore, keeping in view the present study was undertaken to find out the effect of different nutrient and weed management practices on quality and yield of soybean.

Materials and Methods
A field experiment was conducted during *kharif* season of 2016 at the research farm of Tirhut College of Agriculture, Dholi, Muzaffarpur which is situated on the southern bank of the river

Burhi Gandak at an altitude of 52.18 meter above mean sea level and lies at 25º.98' N latitude and 85º.6' E longitude. The soil of the experimental plot was alluvial in nature, having pH 8.3, low in organic carbon (0.41%), available nitrogen, phosphorous and potassium. The experiment was carried out in split-plot design. Nutrient levels having five levels, viz. Control, RDF- N: P_2O_5: K_2O (30: 60: 40 Kg/ha), 50% RDF + FYM 5.0 t/ha, 50% RDF + VC 2.5 t/ha and 50% RDF + FYM 2.5 t/ha + VC 1.25 t/ha in main plot and four weed management viz. Control, Hand weeding at 25 and 45 DAS, Pendimethalin 1.0 kg/ha (Pre-emergance) + one hand weeding at 40 DAS and Pendimethalin 1.0 kg/ha (Pre-emergance) + Imazethapyr 55 g/ha (Post-emergance) at 25 DAS in sub-plot and replicated thrice. The soybean variety, JS-335 was sown on 03 july, 2016 in row 30 cm apart using seed rate of 75 kg/ha. Full dose of nutrients sources applied as basal prior to sowing in band. Pendimethalin was applied next day of sowing and Imazethapyr was applied at 25 DAS. The spraying was done with flat fan nozzle. Hand weeding was done with the help of *khurpi* at 25, 40 and 45 days after sowing as per treatment. Nutrient uptake (N, P and K) in kg/ha by grain and straw of soybean crop was calculated by multiplying yields of grain or straw with contents of nutrient (Black, 1965) [1]. Nutrient uptake was calculated by using the following formula:

Uptake (kg/ha) = Nutrient (%) in Grain/Straw x Grain/Straw yield (q/ha)

The protein content in grain was calculated by multiplying percent nitrogen in the grain by the constant factor 6.25 (Simson *et al*., 1965) [11] and expressed as percent protein content.

Result and Discussion

Yield

Application of Integration of 50% RDF + FYM 2.5 t/ha + VC 1.25 t/ha resulted in significantly superior seed and straw yield than the rest of the treatments but was at par with 50% RDF + FYM 5.0 t/ha (Table 1). Inorganic fertilizer with FYM and vermicompost was superior in grain yield than the application of inorganic fertilizer and no fertiliser. This might be attributed to rapid mineralization of N and steady supply of N from FYM and vermicompost, which might have met the N requirement of crop at critical stages. Further FYM acts as nutrient reservoir and upon decomposition produces organic acids, thereby absorbed ions are released slowly during entire growth period leading to improvement in different yield components thereby resulting in higher seed yield (Maheshbabu *et al*., 2008) [6].

Again 100% RDF also produced a lower seed yield (13.86 q/ha) as compared to the integration of inorganic fertilizers with biological and organic manures. This might be due to the lesser availability of nutrients, especially nitrogen to the crop at the later stages of crop growth when the root nodules degenerate and the nitrogen supply falls short of crop requirements during the pod development phase of the crop. Similar results were also reported in soybean (Singh and Rai 2004). Like grain yield, an increase in stover yield may be due to beneficial effect of FYM and vermicompost which it was applied conjuctive with chemical fertilizers which could be due to synergistic role of FYM and vermicompost in increasing the nutrient availability and sustaining it over period of time as compared to their individual application (Chaturvedi *et al*., 2010) [2].

Hand weeding at 25 and 45 DAS and Pendimethalin 1.0 kg/ha (Pre-emergance) + one hand weeding at 40 DAS and Pendimethalin 1.0 kg/ha (Pre-emergance) + Imazethapyr 55 g/ha (Post-emergance) at 25 DAS produced significantly more grain yield than weedy check which was 90.10 %, 84.98 % and 80.43% more grain yield than unweeded control. This might be due to reduced crop-weed competition for better utilisation of nutrients, moisture and solar radiation are known to improve the yield attributing characters which ultimately expressed in grain yield. This trend was fully reflected in hand weeding and chemical weeding systems. Treatments recording higher grain yield also recorded higher yield of straw in the weed free environment.

Nutrient uptake

Content and uptake of nutrients depends upon available nutrient status of soil, plants vegetative as well as reproductive health, metabolic activity of crop and fertilizer used etc. Nitrogen content in grain and straw was not affected significantly among different nutrient management. P and K content in grain and straw was significantly influenced by different nutrient management. Maximum P and k content in grain and straw was found higher with application of RDF over control but was at par with rest of the treatments. It clearly indicates that reverse trend of yield due to dilution factor. The uptake of N, P and K by soybean plant was significantly influenced by different treatments. Significantly higher uptake of N, P and K was recorded with the application of 50% RDF + FYM 2.5 t/ha + VC 1.25 t/ha followed by 50% RDF + FYM 5.0 t/ha and 50% RDF + VC 2.5 t/ha over RDF and Control (Table 2). The uptake of nitrogen, phosphorus and potassium was more in the plot treated with organic and inorganic fertilizer owing to better availability of phosphorus in crop root zone resulting from its solubilization caused by the organic acids, produced from decaying organic matter and also the increased uptake by the soybean roots due to their association with mycorrhizal filaments increasing the ascribing area of roots. The increase in N uptake might be attributed to enhanced activity of nitrogenase and nitrate reductase enzyme in the soil. Chaturvedi *et al.*, (2010) [2] also recorded the highest uptake of N, P and K with RDF + FYM in soybean. Maximum total N, P and K uptake was noticed with hand weeding twice at 25 and 45 DAS which was significantly superior over control but was statistically at par with Pendimethalin 1.0 kg/ha (Pre-emergance) + one hand weeding at 40 DAS and Pendimethalin 1.0 kg/ha (Pre-emergance) + Imazethapyr 55 g/ha (Post-emergance) at 25 DAS, which might be ascribed to higher yield with these treatments. These results were in close conformity with the finding of Habimana *et al*. (2013) [4].

Quality

The protein content in soybean was not influenced significantly by different levels of integration of inorganic fertilizers with organic manure (Table 1). The highest protein content (36.11%) was obtained when chemical fertilizer was applied at the recommended doses containing N and S in the form urea (N-30 kg/ha) and SSP (P_2O_5-60 kg/ha). As N is a basic constituent of protein and with the increase in rate of N application from organic manures and inorganic fertilizers, the N availability increased which resulted in enhanced protein content in seeds. Besides its protein content also influenced by S content. Because both the nutrients are required for the synthesis of amino acids especially S for cystine, cysteine and methionine which are essential components of protein (Tisdale *et al.*, 1999) [13]. The above findings were in agreement with the results of Sharma *et al.*,

(2002) [10], who reported that protein yield was increased with increased rate of sulphur. Sahoo *et al.,* (2000) [8] also found that protein content increased with higher N rates. In the present investigation, the quality of produce as indicated by protein content did not varies significantly due to different weed management practices. However, maximum protein content was recorded under Pendimethalin 1.0 kg/ha (Pre-emergance) + Imazethapyr 55 g/ha (Post-emergance) at 25 DAS (36.03 %) which was followed by Pendimethalin 1.0 kg/ha (Pre-emergance) + one hand weeding at 40 DAS (35.97 %) and hand weeding at 25 and 45 DAS (35.90 %). The effective weed control owing to these treatments lead to higher nutrient uptake, consequently higher protein content compared to unweeded control. These results are in close conformity with reported by Sharma *et al.,* (2015) [9].

Conclusion

Application of 50% RDF + FYM 2.5 t/ha + VC 1.25 t/ha or 50% RDF + FYM 5 t/ha exhibited almost equal productivity and uptake of nutrients while Pendimethalin 1.0 kg/ha (Pre-emergance) + Imazethapyr 55 g/ha (Post-emergance) at 25 DAS was equally effective for controlling the weed and produced similar yield and uptake of nutrient to that of Pendimethalin 1.0 kg/ha (Pre-emergance) + one hand weeding at 40 DAS and hand weeding twice.

Table 1: Effect of nutrient and weed management on yield, Nutrient Content and protein of soybean

Treatments	Yield (q/ha)		Nitrogen (%)		Phosphorus (%)		Potassium (%)		Protein Content (%)
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	
Nutrient levels									
Control	9.44	19.37	5.72	1.42	0.320	0.033	0.335	1.40	35.75
RDF- N: P_2O_5: K_2O (30: 60: 40 kg/ha)	13.86	23.15	5.78	1.47	0.467	0.048	0.465	1.52	36.11
50% RDF +FYM @ 5 t/ha	16.28	27.50	5.74	1.44	0.450	0.046	0.448	1.50	35.84
50% RDF + VC @ 2.5 t/ha	15.50	26.23	5.75	1.45	0.460	0.047	0.458	1.51	35.92
50% RDF +FYM @ 2.5 t/ha + VC @ 1.25 t/ha	16.94	28.60	5.73	1.43	0.435	0.045	0.433	1.48	35.83
S.Em.±	0.38	0.62	0.12	0.03	0.01	0.001	0.01	0.01	0.76
C.D.(P=0.05)	1.27	2.05	NS	NS	0.033	0.003	0.032	0.05	NS
Weed management									
Control	8.79	17.19	5.72	1.42	0.310	0.033	0.320	1.40	35.76
Hand weeding at 25 and 45 DAS	16.71	28.11	5.74	1.43	0.454	0.046	0.452	1.48	35.85
Pendimethalin @ 1.0 kg/ha as PE + one hand weeding at 40 DAS	16.26	27.65	5.75	1.44	0.462	0.047	0.460	1.51	35.91
Pendimethalin @ 1.0 kg/ha as PE and imazethapyr @ 55 g/ha as PoE at 25 DAS	15.86	26.93	5.77	1.46	0.481	0.049	0.479	1.53	36.04
S.Em.±	0.37	0.64	0.13	0.03	0.010	0.001	0.01	0.02	0.82
C.D.(P=0.05)	1.10	1.86	NS	NS	0.03	0.003	0.03	0.06	NS

Table 2: Effect of nutrient and weed management on Nutrient uptake of soybean

Treatments	Nitrogen Uptake (kg/ha)		Phosphorus uptake (kg/ha)		Potassium uptake (kg/ha)		Total Uptake (kg/ha)		
	Grain	Straw	Grain	Straw	Grain	Straw	N	P	K
Nutrient levels									
Control	54.32	27.40	3.21	0.64	3.28	27.53	81.72	3.85	30.80
RDF- N: P2O5: K2O (30: 60: 40 kg/ha)	80.39	34.18	6.69	1.15	6.67	39.51	114.58	7.84	46.17
50% RDF +FYM @ 5 t/ha	93.97	39.75	7.60	1.29	7.57	41.57	133.72	8.89	49.13
50% RDF + VC @ 2.5 t/ha	90.13	38.35	7.43	1.28	7.40	39.84	128.48	8.71	47.24
50% RDF +FYM @ 2.5 t/ha + VC @ 1.25 t/ha	98.84	41.60	7.78	1.33	7.74	42.79	140.39	9.11	50.53
S.Em.±	4.34	1.77	0.36	0.06	0.36	1.15	6.10	0.42	1.50
C.D.(P=0.05)	14.37	5.86	1.21	0.20	1.20	3.81	20.22	1.41	4.96
Weed management									
Control	50.92	24.74	2.85	0.58	2.88	24.26	75.66	3.43	27.14
Hand weeding at 25 and 45 DAS	96.55	40.38	7.81	1.34	7.78	42.06	136.92	9.15	49.84
Pendimethalin @ 1.0 kg/ha as PE + one hand weeding at 40 DAS	94.47	40.15	7.78	1.33	7.75	41.95	134.62	9.11	49.70
Pendimethalin @ 1.0 kg/ha as PE and imazethapyr @ 55 g/ha as PoE at 25 DAS	92.19	39.73	7.73	1.31	7.70	41.50	131.91	9.04	49.20
S.Em.±	4.41	1.86	0.37	0.06	0.37	1.45	6.27	0.43	1.80
C.D.(P=0.05)	12.78	5.39	1.07	0.18	1.07	4.20	18.18	1.25	5.23

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