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Impact of Long Term application of inorganic fertilizer and farmyard manure on Productivity of Soybean in Vertisol

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ABSTRACT

This study aimed to investigate the impact of long term application of inorganic fertilizers and farmyard manure on pattern of nutrient content, nutrient uptake and yield of soybean in vertisol under LTFE. The field experiments was conducted on the Research Farm of Department of Soil Science and Agricultural Chemistry, JNKVV, Jabalpur during 2015-16 with ten treatments i.e. 50% NPK, 100% NPK, 150% NPK, 100% NPK+HW, 100% NPK+Zn, 100% NP, 100% N, 100% NPK+FYM, 100% NPK-S and control with four replications in simple randomized block design. The present investigation is a part of All India Coordinated Research Project (AICRP) ongoing Long-term fertilizer experiment that was began in 1972 and is continuing till date. The highest yield was associated with integrated application of fertilizer along with Farmyard manure (100% NPK + FYM) in comparison to optimal dose of NPK (100% NPK).While, the lowest yield was found in control as well as 100 % N alone. But supplementation of fertilizer P with N (100% NP) enhanced the yields in soybean. Moreover, applied 150 % NPK observed the higher yield as compared to 100 % NPK and 50 % NPK. Similar trend was also marked for content and uptake pattern of nutrient in soybean. However, in general higher content and uptake of nutrients was found in grain as compared to straw.
Key Words: Farmyard manure, Yield, Nutrient uptake, Harvest index, Soil properties

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INTRODUCTION

Soybean (*Glycine max* (L.) Merrill), a leguminous oil seed crop, is predominantly grown in the Vertisol of Central India as a rainfed crop [6]. The productivity of soybean is low in this region due to erratic distribution of monsoonal rains, imbalanced use of major and minor nutrients, continuously growing of soybean in the same piece of land and low organic carbon status of soil. Results from different studies revealed that continuous application of farmyard manure and green manure improved the soil organic carbon under different soils and cropping systems [21, 28, 17]. Therefore any nutrient management practice that can improve organic matter status of soil helps in sustaining crop productivity at higher level.

The continuous use of high level of chemical fertilizers has been led to the problem of soil degradation, which is being proven detrimental to crop production in our country. The balanced fertilization has required for crop production, but combined application of manure may reduce the need for chemical fertilizer. An application of chemical fertilizers in combination with FYM may increase the yield and yield contributing characters such as grain yield, straw yield and biological yield, nutrient content and nutrient uptake, hence ultimately resulting in increased productivity of soybean [26]. Use of organic manure alone or in combination with chemical fertilizers will help to improve physicochemical properties of the soils [19]. Therefore, adequate and balanced application of organic and inorganic fertilizers is necessary to increase productivity and soil fertility. The study was conducted to find out the application of suitable combination of FYM and inorganic fertilizers (NPK) in order to obtain better soybean yield, nutrient content and nutrients uptake.

MATERIAL AND METHODS

Present study was conducted during 2015 in Kharif season at experimental site of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India (23°10′N, 79°57′E), under wheat (Triticumaestivum L.) as winter and soybean (Glycine max (L.) Merrill) as rainy season crops under LTFE. The region has a semi-arid and sub-tropical climate, with a mean annual temperature of 25.7°C and precipitation of 1350mm. Soil details; medium black soil classified as Vertisol, with pH of 7.6 in soil-water suspension (1:2.5), 0.18 dS m^{-1}electrical conductivity, 0.57% organic carbon, 193.0 kg ha^{-1} available N, 7.60 kg ha^{-1} available P, and 370 kg ha^{-1} available K, 17.47 kg ha^{-1}available S and 0.33 kg ha^{-1} available Zn, and bulk density of 1.3 Mg m^{-3}, and particle size distribution of 56.82% clay, 17.91% silt, and 25.27.0% sand. The experiment consisted of 10 treatments replicated four times in a randomized block design consist of gross plot size 17x10.8 m with 1 m spacing between plots and 2 m spacing between the replications with soybean variety JS 97-52;included; 100% NPK (43.4, 500, and 33.33 kg ha^{-1} Urea, SSP, and MOP, respectively), 150% NPK (65.1, 750, and 49.99 kg ha^{-1} Urea, SSP, and MOP, respectively), combination of 100% NPK+ FYM (5 t ha^{-1}), and no fertilizer (control). Inorganic fertilizers include urea (460 g N kg^{-1} of Urea), super phosphate (160 g P kg^{-1} of Super phosphate), and potassium chloride (600 g K kg^{-1} of MOP) as the sources of N, P, and K respectively.

Soil samples were collected from each treatment before sowing and after harvesting, five random cores were taken from a depth of 0 to 15 cm using a sampling auger. Subsamples were pooled to make composite samples. Composite samples were air-dried at room temperature, pulverized, sieved through a 2-mm sieve. All soybean plants were harvested at crop maturity and grain yield was obtained. Next to this, grain nutrients NPK were analyzed [2, 3] and nutrient uptake was calculated by using the following formula: Nutrient uptake (kg^{-1} ha) = Nutrient content (%) × yield (kg ha^{-1}).

RESULT AND DISCUSSION

Impact of long term fertilizer and FYM application on yield of soybean

The data presented in (Table 1 & fig. 1) illustrated that grain yield for recommended optimal dose (100% NPK) was 900 kg ha^{-1} which was higher than exclusion of sulphur (i.e. 100% NPK-S) dose that was 750 kg ha^{-1}. The lowest grain yield was recorded in control which was 313 kg ha^{-1}. While, it was found to be increased (625 kg ha^{-1}) in treatment receiving sub optimal fertilizer dose (50% NPK), which was significantly higher than application of 100% N alone (325 kg ha^{-1}). Similar results have also been observed by Kushwaha *et al*., [18] and Behera *et al*., [1]. On the other hand, the grain yield obtained in conjoint use of FYM with 100 % NPK treatment (1200 kg ha^{-1}) which was significantly higher than 150% NPK treatment (1150 kg ha^{-1}). Similarly, it was also found that 100% N treatment recorded lower yield (325 kg ha^{-1}) which progressively increased to 825 kg ha^{-1} when P fertilizer (100% NP) was added in fertilizer schedule, a further improvement was noticed 900 kg ha^{-1} when K fertilizer included (100% NPK) in imbalance application of NP (100% NP) [20, 24]. These results showed the importance of phosphorous application and found to be a major fertility constraint in controlling productivity of soybean grown especially in black soil [9, 10]. The highest grain yield was recorded where 150% NPK was applied in comparison to 100% NPK and 50% NPK [11].

The perusal of the data (Table 1 & fig.1) indicated that the highest straw yield was recorded with conjoint application of FYM with optimal dose of inorganic fertilizer i.e. 100 % NPK+FYM (2038 kg ha^{-1}) significantly higher than 100 % N alone (1750 kg ha^{-1}). The lowest straw yield was noticed in control (1738 kg ha^{-1}).It was found to be increased (1875 kg ha^{-1}) when P fertilizer (100 % NP) was included in fertilizer schedule. The maximum straw yield was recorded with application of super optimal dose of 150 % NPK (2025 kg ha^{-1}) and optimal dose of 100% NPK (1975 kg ha^{-1}) followed by sub optimal dose of 50% NPK (1850 kg ha^{-1}).Identical findings were reported by Kundu *et al*., [17], Chakraborty and Hazari, [4] and Dwivedi *et al*., [10].

The data (Table 1 & fig. 1) depicted that the biological yield obtained in 100% NPK + FYM treatment (3238 kg ha^{-1}) was significantly higher than 100 % N alone (2075 kg ha^{-1}) [7, 5, 20]. On the other hand, the lowest biological yield was recorded in control (2050 kg ha^{-1}).Whereas, it was found to be significantly increased (2875 kg ha^{-1}) when K fertilizer was added in imbalance application of fertilizer followed by application of dose of 100% NP fertilizer (2700 kg ha^{-1}). Application of recommended optimal dose (100% NPK) resulted in productivity of biological yield for 2875 kg ha^{-1} but exclusion of sulphur (i.e. 100% NPK-S) dose had resulted in comparatively lower biological yield (2750 kg ha^{-1}). Similar results have also been observed by Hati *et al*., [14] and Kundu *et al*., [16].

Impact of long term fertilizer and FYM application on nitrogen, phosphorus and sulphur content and their uptake of soybean

It is fact that plant utilizes the nutrient which is available in soil pool concentration with successive addition of fertilizer and manure. In this regard, the data presented in Table (2) & (3) and illustrated in Fig. (2) & (5) revealed that N content and uptake in grain were recorded with conjoint use of 100 % NPK + FYM (6.81% and 81.8 kg ha^{-1} respectively) significant higher than over imbalanced dose of fertilizer. On the other hand, the lower content and uptake of N were found in 100% N alone (3.58% and 11.7 kg ha^{-1} respectively) as well as in control (3.55% and 11.2 kg ha^{-1} respectively). N content and uptake in grain were recorded higher under the balance application of NPK (5.38 % and 48.3 kg ha^{-1} respectively) followed by when sulphur was excluded from fertilizer schedule i.e. 100% NPK-S (4.65% and 35 kg ha^{-1} respectively). Identical findings were reported by Dubey and Shrivastava [7]. The highest N content and uptake in grain and straw were recorded where 150% NPK were applied, as compared to 100% NPK and 50% NPK dose [9]. Similar trend of N content and uptake were also noticed in case of straw.

Table (2) & (3) and Fig. (3) & (5) depicted that the maximum P content and uptake in grain were associated with integrated application of NPK along with FYM (0.54% and6.4 kg ha^{-1} respectively) followed by 150% dose of NPK (0.45% and 5.2 kg ha^{-1} respectively). While, the lower content and uptake of P in grain were found in 100% N alone (0.16% and 0.5 kg ha^{-1} respectively)as well as in control plots (0.41% and 0.4 kg ha^{-1}respectively). The P content and uptake in grain progressively increased when P fertilizer (100 % NP) was included in fertilizer schedule (0.26% and 2.1 kg ha^{-1} respectively). There was a improvement of P content and uptake in grain were noticed when K nutrient added (100% NPK) which was higher than when sulphur was excluded from balance dose of fertilizer (100%NPK-S). P content and uptake in grain were recorded with conjoint use of 100 % NPK + FYM significant higher than over imbalanced dose of fertilizer. Similar, trend of P content and uptake was also noticed in case of straw as reported by Ravankar *et al.,* [23] and Gupta *et al*., [13].

The data (Table 2 & 3) and Fig. (4&5) represented that the total S content as well as S uptake in grain and straw increased with each increment of applied NPK fertilizers. On the contrary, the lowest content and uptake of S in grain were noted in control (0.15 % and 0.5 kg ha^{-1}respectively) and 100% N(0.16 % and 0.5 kg ha^{-1}respectively) which could be reported by Sime and Nand Ram [27]. The maximum S content and uptake in grain were found in optimal dose of fertilizer applied with FYM i.e.100%NPK+FYM (0.46 % and 5.6 kg ha^{-1}respectively). The data also revealed that the maximum values of S content were attained in grain rather than the straw. S content and uptake in grain were recorded with conjoint use of 100 % NPK + FYM significant higher than over imbalanced dose of fertilizer. The highest S content and uptake in grain and straw were recorded where 150% NPK were applied, as compared to 100% NPK and 50% NPK dose. Similar trend of S content and uptake were also noticed in case of straw. As an essential constituent of amino acids, the sulphur transformed into organic compounds which accumulates as seed storage reserves, there by leading to a apparent depletion of S content and low uptake in straw as reported by Sharma [25]; Raghuwanshi *et al*. [22] and Jadhav *et al.* [15].

Table 1: Impact of long term fertilizer and FYM application on yield (Kg ha^{-1}) of soybean

Treatments	Soybean yield (Kg ha^{-1})		
	Grain yield	Straw yield	Biological yield
T_1 50%NPK	625	1850	2475
T_2 100%NPK	900	1975	2875
T_3 150%NPK	1150	2025	3175
T_4 100%NPK+HW	775	1725	2500
T_5 100%NPK+Zn	775	1850	2625
T_6 100%NP	825	1875	2700
T_7 100%N	325	1750	2075
T_8 100%NPK+FYM (5t/ha)	1200	2038	3238
T_9 100%NPK – S	750	2000	2750
T_{10} Control	313	1738	2050
SEm ±	35.77	82.30	95.19
CD (p=0.05)	103.80	238.83	134.62
CV(%)	9.37	8.74	7.19

Table 2: Impact of long term fertilizer and FYM application on nutrient content of soybean

Treatments	Nutrient content (%)					
	N		P		S	
	Grain	Straw	Grain	Straw	Grain	Straw
T_1 50%NPK	4.63	2.00	0.25	0.16	0.21	0.17
T_2 100%NPK	5.38	2.30	0.31	0.21	0.29	0.23
T_3 150%NPK	6.10	2.63	0.45	0.24	0.41	0.26
T_4 100%NPK+HW	5.40	2.31	0.32	0.20	0.29	0.22
T_5 100%NPK+Zn	5.42	2.33	0.32	0.22	0.29	0.23
T_6 100%NP	4.60	1.95	0.26	0.16	0.25	0.18
T_7 100%N	3.58	1.61	0.16	0.12	0.16	0.14
T_8 100%NPK+FYM	6.81	2.97	0.54	0.28	0.46	0.30
T_9 100%NPK – S	4.65	2.00	0.30	0.17	0.21	0.19
T_{10} Control	3.55	1.60	0.14	0.08	0.15	0.10
SEm ±	0.24	0.10	0.01	0.01	0.01	0.01
CD (p=0.05)	0.70	0.29	0.03	0.03	0.02	0.03
CV(%)	9.62	9.21	5.81	11.89	5.59	11.72

Table 3: Impact of long term fertilizer and FYM application on nutrient uptake by soybean

Treatments	Nutrient uptake (Kg ha^{-1})								
	N			P			S		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T_1 50%NPK	28.8	36.8	65.6	1.6	3.0	4.6	1.3	3.2	4.5
T_2 100%NPK	48.3	45.4	93.7	2.8	4.2	7.0	2.6	4.6	7.3
T_3 150%NPK	70.1	53.5	123.6	5.2	5.0	10.1	4.7	5.4	10.0
T_4 100%NPK+HW	41.8	40.0	81.8	2.5	3.5	6.0	2.2	3.8	6.1
T_5 100%NPK+Zn	42.0	43.0	85.0	2.5	4.0	6.5	2.2	4.3	6.6
T_6 100%NP	38.2	36.5	74.6	2.1	3.1	5.2	2.1	3.4	5.5
T_7 100%N	11.7	28.2	39.9	0.5	2.1	2.6	0.5	2.5	3.0
T_8 100%NPK+FYM	81.8	60.6	142.3	6.4	5.6	12.0	5.6	6.0	11.6
T_9 100%NPK – S	35.0	40.0	75.0	2.3	3.4	5.7	1.6	3.8	5.4
T_{10} Control	11.2	27.8	39.0	0.4	1.4	1.8	0.5	1.7	2.2
SEm ±	2.81	3	3.70	0.10	0.32	0.34	0.09	0.35	0.37
CD (p=0.05)	8.15	8.70	10.74	0.30	0.93	0.99	0.26	1.01	1.07
CV(%)	13.74	14.56	9.02	7.97	18.09	11.10	7.70	17.84	11.84

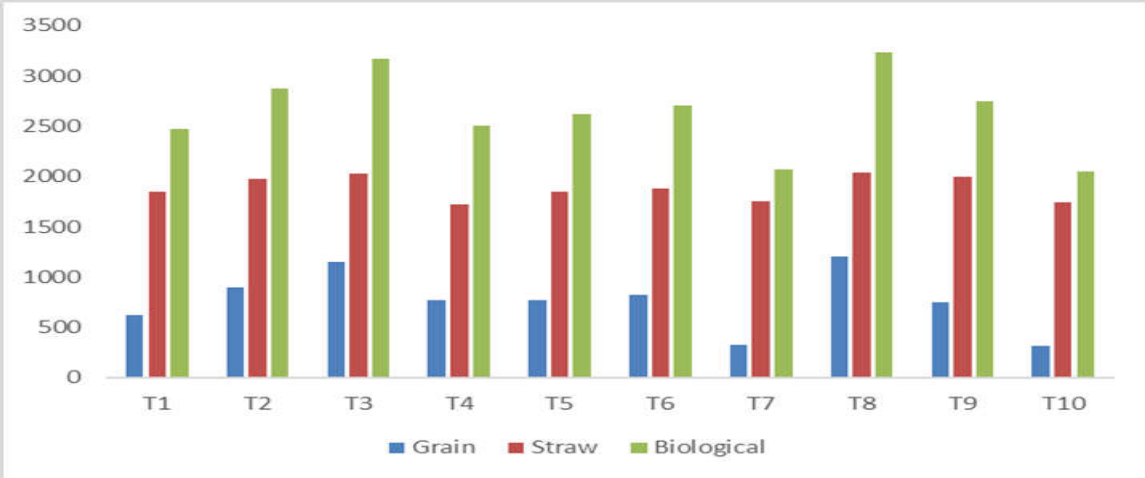

Figure 1.Impact of long term application of fertilizers and manure on grain, straw and biological yield of soybean

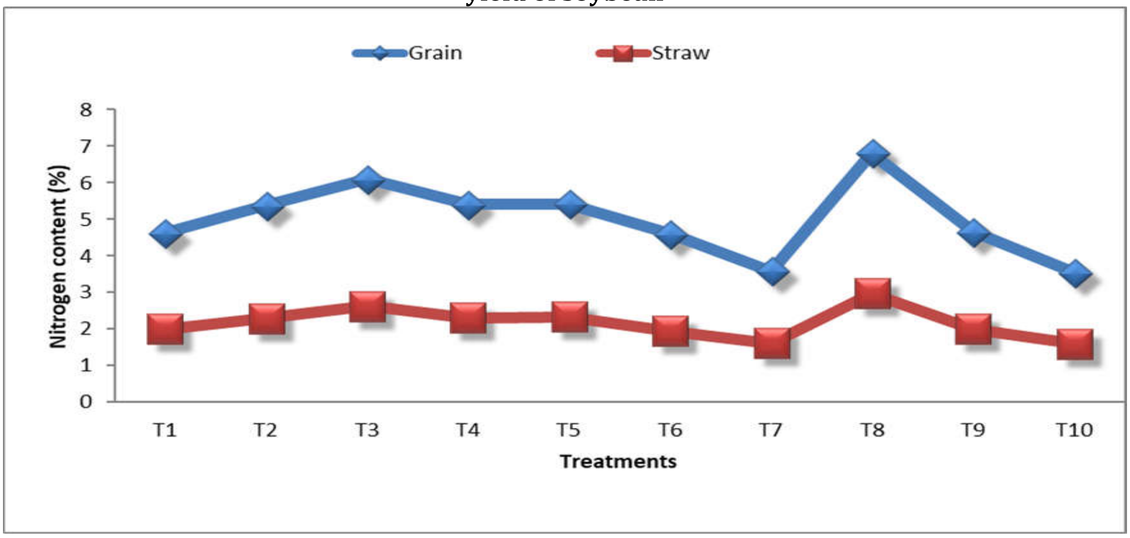

Figure 2.Impact of long term application of fertilizers and manure on nitrogen content of soybean

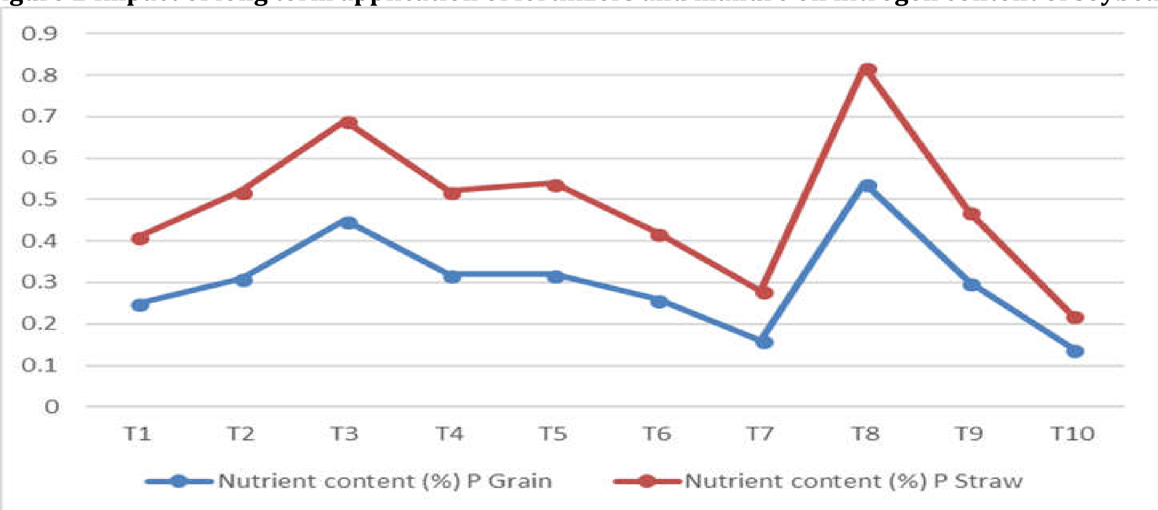

Figure 3.Impact of long term application of fertilizers and manure on phosphorus content of soybean

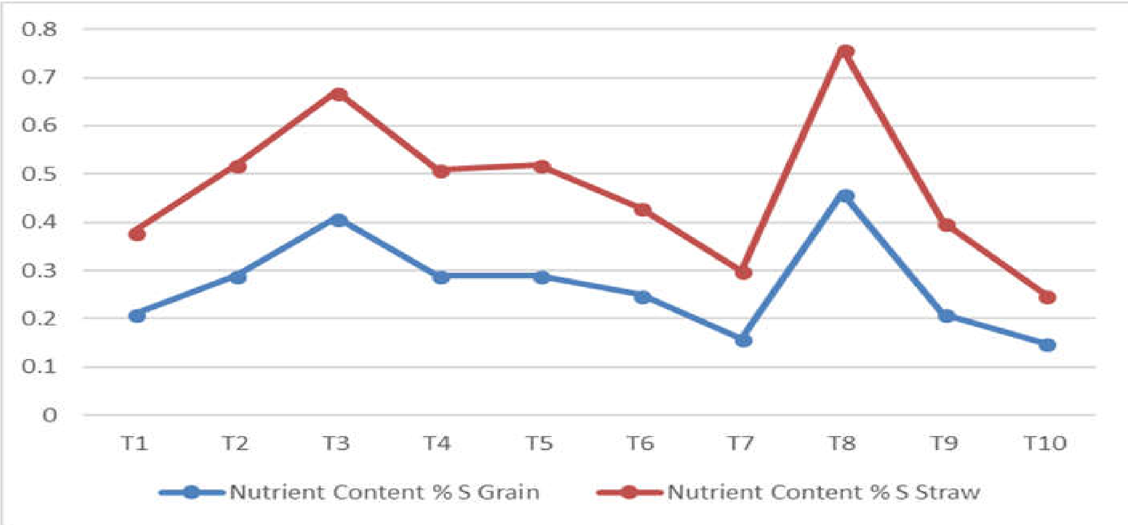

Figure 4.Impact of long term application of fertilizers and manure on Sulphur content of soybean

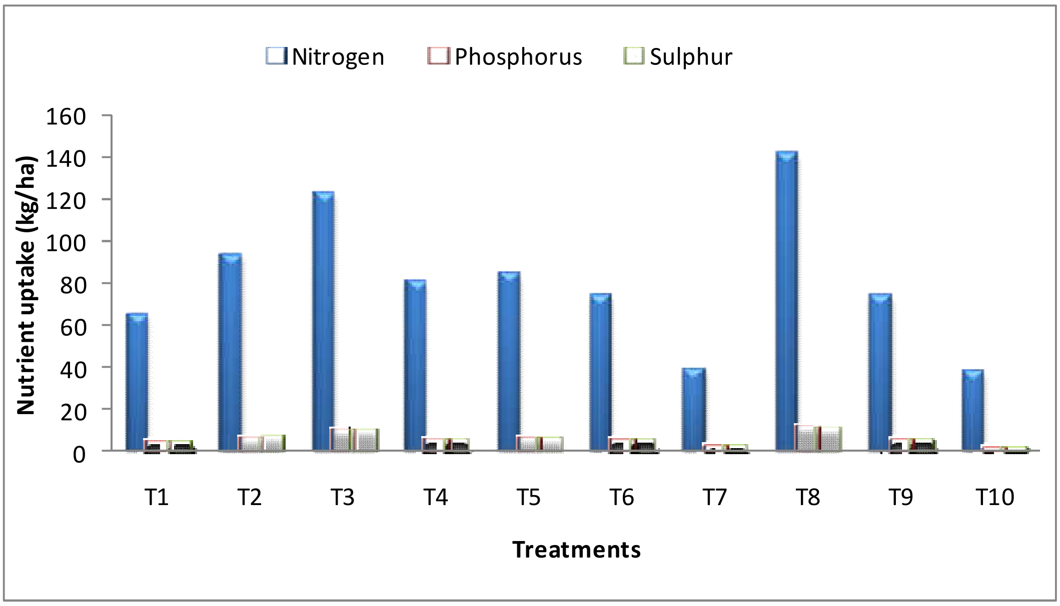

Figure 5.Impact of long term application of fertilizers and manure on total nutrient uptake of soybean crop

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