International Journal of Plant & Soil Science

34(22): 1570-1576, 2022; Article no.IJPSS.91798
ISSN: 2320-7035

Influence of Long-term Application of Fertilizers and Manure on Growth, Yield Attributes and Yield of Soybean

Kiran Patel [a*], P. S. Kulhare [a], Arunendra Kumar Patel [b], G. S. Tagore [a], B. L. Lakaria [c] and Aakanksha Lanjhewar [d]

[a] Department of Soil Science, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, India.
[b] Department of Physics, Amar Veerangana Rani Durgavati Government College, Tendukheda, Damoh, India.
[c] Department of Soil Science, Indian Institute of Soil Science, Bhopal, India.
[d] Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2022/v34i2231534

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/91798

Original Research Article

Received 05 July 2022
Accepted 10 September 2022
Published 12 September 2022

ABSTRACT

A field experiment was conducted under on-going Long-Term Fertilizer Experiment during 2020 and 2021 at the Research farm, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, to study the influence of long-term application of fertilizers and manure on growth, yield attributes and yield of soybean. There were eight treatments comprised of T_1 (50% NPK), T_2 (100% NPK), T_3 (150% NPK), T_4 (100% NP), T_5 (100% N), T_6 (100% NPK + FYM), T_7 (100% NPK - S) and T_8 (control). The treatments were replicated four times in a randomized block design. The soybean (RVS 2001-4) was grown with recommended dose of 20:80:20 (100% N:P_2O_5:K_2O kg ha^{-1}) in *kharif* season. The application of 50% NPK, 100% NPK and 150% NPK significantly increased the plant height, pod length, number of pods $plant^{-1}$, number of seeds pod^{-1}, test weight (100 seeds), seed and stover yield of soybean over control. While the plant height and pod length at 150% NPK were found significantly superior to 50% NPK. However, the number of pods $plant^{-1}$, test weight (100

**Corresponding author: E-mail: kiran08.rmd@gmail.com;*

seeds), seed and stover yield of soybean successively and significantly increased with 50% NPK, 100% NPK and 150% NPK. While the number of seeds pod^{-1} significantly increased with 100% NPK and 150% NPK over 50% NPK but the two treatments were found at par. The application of 100% NPK + FYM significantly increased the plant height, pod length, number of pods plant^{-1}, number of seeds pod^{-1}, test weight (100 seeds), seed and stover yield of soybean over 50% NPK, 100% NPK and 100% NP and 100% N. However, the application of 100% NPK + FYM was found significantly superior to 150% NPK for plant height and number of seeds pod^{-1}. The growth and yield attributes were found significantly and positively correlated with seed and stover yield.

Keywords: Soybean; growth; yield attributes; yield; correlation co-efficient.

1. INTRODUCTION

"Soybean is extensively grown in all over Madhya Pradesh because of its wide adaptability to agro-climatic conditions and better market value. Soybean production in India during 2019-20 was estimated as 112.15 lakh tonnes from an area of 120.91 lakh hectares with productivity of 928 kg ha^{-1}" [1]. "In Madhya Pradesh, soybean production during 2019-20 was estimated as 38.56 lakh tonnes from an area of 61.94 lakh hectares with productivity of 623 kg ha^{-1}" [2]. For its high capacity to fix nitrogen, soybean is regarded as a natural fertilizer factory. Being a legume crop, it is supposed to enhance the production of succeeding crops and the health of the soil [3]. It has a high nutritional value and contains, a high amount of protein (42-43%), edible oil (18-20%) and vitamins (A and D). Additionally, it contains a lot of carbohydrates (30%) and fibre (4%). As a result, it is sometimes referred to as "golden bean" and false meat. The declining production in India is mostly caused by insufficient nutrients in the soil or an imbalance in the crop's nutrition. The physical, chemical and biological qualities of soil are degraded over time by using inorganic fertilizers alone without organic additives, which also pollute the environment [4]. Therefore, a proper nutrition is necessary to maximize agricultural output. As a result, there is a significant need to implement integrated nutrient management, which involves the judicious use of chemical fertilizers and organic manures, in order to increase crop yield, maintain the health of the soil, conserve resources and the environment. Long-term experiments are conducted with the aim for monitoring the impact of fertilizer management on soil fertility and sustainability of a production system [5]. Real estimates of nutrient content during the crop growth will not only help in assessing the amount of fertilizer added to soil but will also help in assessing the soil fertility status to develop the strategies for crop production [6]. In consideration of this, the current inquiry was designed to evaluate the influence of long-term application of fertilizers and manure on growth, yield attributes and yield of soybean.

2. MATERIALS AND METHODS

2.1 Experimental Site, Climate and Soil Characteristics

Present study was conducted under All India Coordinated Research Project (AICRP) on Long Term Fertilizer Experiment (LTFE) of Indian Council of Agricultural Research (ICAR). The experiment is laid out on a permanent site at the Research field of Department of Soil Science, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh. The experimental site is located in 'Kymore Plateau and Satpura Hills' agro climatic region of Madhya Pradesh. It falls on 23.9° N latitude and 79.6° E longitudes with an altitude of 411.8 m above the mean sea level. Jabalpur is situated in the semi-arid region having sub-tropical climate with hot dry summer and cold winter. The average rainfall is about 1350 mm, which is mainly distributed from mid-June to October. The maximum and minimum temperature ranges between 35.1°C and 5.3°C. The average annual relative humidity is 62-70%. The experiment was started in 1972, the cropping sequence being followed is soybean (*Kharif*) and wheat (*Rabi*). The soil of the experimental field is medium black belongs to Kheri series of fine montmorillonitic hyperthermic family of Typic Haplustert.

2.2 Treatments Detail

The experiment was started since 1972. The 100% optimal NPK dose was 20:80:20 ($N:P_2O_5:K_2O$ kg ha^{-1})) for soybean based on soil test value during 1972. Nitrogen, phosphorus and potassium were applied through urea, single super phosphate and muriate of potash

respectively. In 100% NPK - S, where application of sulphur was omitted therefore, di-ammonium phosphate was used as a source for phosphorus. The farm yard manure (FYM) treatment was applied @ 5-ton ha^{-1} $year^{-1}$ to soybean crop. There were eight treatments i.e., T_1 (50% NPK), T_2 (100% NPK), T_3 (150% NPK), T_4 (100% NP), T_5 (100% N), T_6 (100% NPK + 5FYM), T_7 (100% NPK - S) and T_8 (control). These treatments were replicated four times in a randomized block design (RBD).

2.3 Growth and Yield Attributes

The soybean crop (RVS 2001-4) was grown in *kharif* season. The crop was sown in 02-07-2020 and 03-07-2021 @ 100 kg ha^{-1} seed rate with row-to-row distance of 40 cm and harvested at physiological maturity on 24-10-2020 and 28-10-2021 respectively. Growth and yield attributes were recorded in five plants randomly selected in each plot. The physiological observation such as plant height, pod length, number of pods $plant^{-1}$, number of seeds pod^{-1} and test weight (100 seeds) were recorded at the harvest.

2.4 Statistical Analysis

In the present study the data analysis for randomized block design has been performed using standard technique defined by Gomez and Gomez [7].

3. RESULTS AND DISCUSSION

3.1 Growth and Yield Attributes

The data presented in Table 1 and Fig. 1 indicated that the application of 50% NPK, 100% NPK and 150% NPK significantly increased the plant height, pod length, number of pods $plant^{-1}$, number of seeds pod^{-1}, and test weight of soybean over control. The application of 150% NPK significantly increased the plant height of soybean over 50% NPK and 100% NPK but the treatments 50% NPK and 100% NPK were found at par. The application of 100% NPK and 100% NP were found significant over 100% N but the two treatments were found at par with 100% NPK - S for plant height. The application of 150% NPK also significantly increased the pod length of soybean over 50% NPK but the treatment was found at par with 100% NPK. However, the number of pods $plant^{-1}$ and test weight successively and significantly increased with the increasing levels of NPK. While the number of seeds pod^{-1} significantly increased with the application of 100% NPK and 150% NPK over 50% NPK but the two treatments were found at par. The application of 100% NPK was found significantly superior to 100% NP and 100% N but it was found at par with 100% NPK - S for number of seeds pod^{-1}. Though the 100% NP was found significantly superior to 100% N for pod length, number of pods $plant^{-1}$, number of seeds pod^{-1} and test weight of soybean. This increase of growth and yield attributes of soybean with increasing levels of NPK might be due to increased nutrients availability in soil promotes the root and shoot growth of soybean which enhanced the nutrients absorption by plants under intensive cultivation. While the lowest values of growth and yield attributes were observed in control or 100% N only might be due to the continuous absence of NPK addition in soil under the nutrients deficient condition in soil attributed to poor root and shoot development resulted lower values of growth and yield attributes of soybean. The significant higher pod length, number of pods $plant^{-1}$, number of seeds pod^{-1} and test weight with 100% NP than 100% N alone might be due to beneficial effect of N and P application in increasing the nutrients availability in soil which promote root and shoot growth which enhanced the nutrients absorption hence resulted higher yield attributes than 100% N alone which adversely affected the soil structure as it decreased soil aggregation due to poor crop development as a result of imbalance nutrition.

The application of 100% NPK + FYM significantly increased the plant height, pod length, number of pods $plant^{-1}$, number of seeds pod^{-1} and test weight of soybean over 100% NPK and 100% NPK - S, 100% NP and 100% N. However, the application of 100% NPK + FYM was also found significantly superior to 150% NPK for plant height and number of seeds pod^{-1}. It might be due to continuous application of FYM along with 100% NPK supply better nutrition (major and minor nutrients) under better soil condition promote better root and shoot growth resulted higher growth and yield parameters of soybean. The increase of growth and yield characters with NPK + FYM application also reported by Tanwar and Shaktawat [8], Rathiya and lakpale [9], Senthivelu and Prabha [10], Maheshbabu et al. [11], Chiezey and Odunze [12], Khaim et al. [13] and Hekmat et al. reported the growth and yield of soybean were significantly influenced by the application of various levels of Farm Yard Manure and recommended dose of fertilizers [14].

Table 1. Influence of long-term application of fertilizers and manure on growth and yield attributes of soybean at harvest (Pooled data of 2020 and 2021)

Treatments	Plant height (cm)	Pod length (cm)	No. of pods plant^{-1}	No. of seeds pod^{-1}	Test weight (g)
50% NPK	41.91	3.38	24.50	1.63	7.32
100% NPK	42.46	3.50	27.38	2.38	8.49
150% NPK	44.44	3.61	35.38	2.63	9.82
100% NP	42.29	3.43	25.75	1.88	7.73
100% N	41.20	3.16	17.75	1.42	6.26
100% NPK + FYM	45.50	3.71	36.88	2.88	9.98
100% NPK - S	41.93	3.45	26.63	2.13	8.07
Control	39.33	2.58	15.63	1.13	5.85
SEm ±	0.37	0.07	0.58	0.10	0.08
CD (*p*=0.05)	1.06	0.20	1.66	0.28	0.24

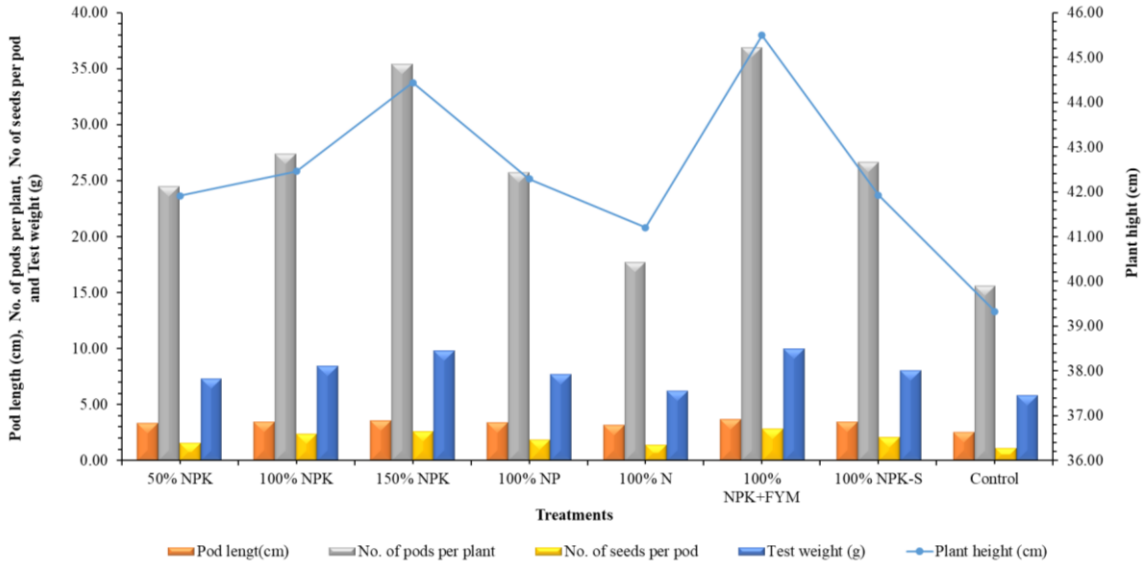

Fig. 1. Influence of long-term application of fertilizers and manure on growth and yield attributes of soybean

3.2 Seed and Stover Yield of Soybean

The data presented in Table 2 and Fig. 2 indicated that the application of 50% NPK, 100% NPK and 150% NPK successively and significantly increased the seed and stover yield of soybean. The 100% NPK was found significantly superior to 100% NP and 100% N for seed yield but it was found at par with 100% NPK - S. While the stover yield was also found significantly superior to 100% N and 100% NPK - S. The application of 100% NP was found significantly superior to 100% N for seed and stover yield. This increase of seed and stover yield of soybean with increasing levels of NPK which support normal development of the crops, their residues and decaying root induced soil aggregation which promote root and shoot development enhanced growth and yield attributes responsible for higher seed and stover yield. While the lowest seed and stover yield in control due to lack of the essential nutrients restricted optimum plant development hence lower growth and yield attributes. The significantly higher seed and stover yield of soybean with 100% NP than 100% N might be due to the beneficial effect of N and P in increasing the nutrients availability which promote root and shoot development hence better growth and attributes of soybean than 100% N alone which adversely affected the soil structure and decreased soil aggregation resulted poor growth and yield attributes.

The application of 100% NPK + FYM significantly increased the seed and stover yield of soybean

over 50% NPK and 100% NPK - S, 100% NP and 100% N but it was found at par with 150% NPK. It might be due to beneficial effect of continuous application of FYM + 100% NPK which supply better nutrients (including major and minor nutrients) under better soil condition produced higher growth and yield attributes resulted significantly higher seed and stover yield than NPK alone. The lower seed and stover yield with 100% NPK - S than 100% NPK might be due to lack of S supply might reduce the root and shoot growth resulted lower growth and yield attributes than 100% NPK. The seed and stover yield of soybean were found significantly and positively correlated with plant height (r =0.952 and 0.955), pod length (r =0.898 and 0.920), number of pods plant^{-1} (r = 0.993 and 0.985), number of seeds pod^{-1} (r = 0.981 and 0.964) and test weight (r = 0.996 and 0.984) respectively (Table 3). The similar results were also reported by Kundu et al. [15], Bandyopadhyay et al. [16] and Bhattacharya et al. [17]. Nagwanshi et al. revealed that the continuous fertilizers and manure application resulted in a significant response in seed and stover yield of soybean in a Vertisol [18].

Table 2. Influence of long-term application of fertilizers and manure on seed and stover yield of soybean (Pooled data of 2020 and 2021)

Treatments	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
50% NPK	1356	2898
100% NPK	1684	3296
150% NPK	2026	3754
100% NP	1481	3026
100% N	950	2241
100% NPK + FYM	2110	3828
100% NPK - S	1528	2934
Control	811	1918
SEm ±	64	125
CD (*p*=0.05)	182	357

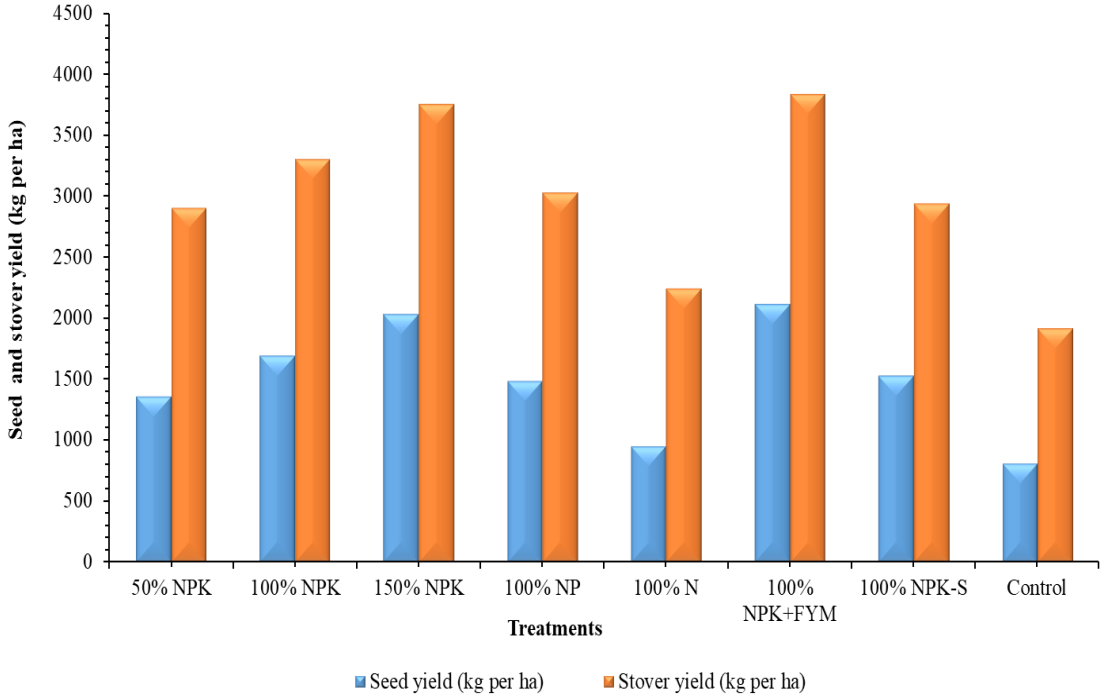

Fig. 2. Influence of long-term application of fertilizers and manure on seed and stover yield of soybean

Table 3. Correlation between yield and growth/yield attributes of soybean

Characters	Seed yield	Stover yield
Plant height	0.952	0.955
pod length	0.898	0.920
Number of pods plant^{-1}	0.993	0.985
Number of seeds pod^{-1}	0.981	0.964
test weight	0.996	0.984
Significant at 5% level of significance (critical r value is 0.707)		

3.3 Correlation Studies

The correlation co-efficient values ("r") were worked out for seed and stover yield versus plant height, pod length, number of pods plant^{-1}, number of seeds pod^{-1} and test weight. Seed yield had significantly positive correlation with plant height (r =0.952), pod length (r =0.898), number of pods plant^{-1} (r = 0.993), number of seeds pod^{-1} (r = 0.981) and test weight (r = 0.996) respectively. Stover yield had significantly positive correlation with plant height (r =0.955), pod length (r =0.920), number of pods plant^{-1} (r = 0.985), Number of seeds pod^{-1} (r = 0.964) and test weight (r = 0.984) respectively. Similar finding was also reported by Hekmat et al. [19].

4. CONCLUSION

It can be concluded that number of pods plant^{-1}, test weight, seed and stover yield of soybean successively and significantly increased with 50% NPK, 100% NPK and 150% NPK. The application of 100% NPK + FYM significantly increased the growth and yield attributes, seed and stover yield of soybean over 100% NPK and 100% NPK - S.

ACKNOWLEDGEMENTS

The authors are thankful to ICAR for providing funds for the study and the Department of Soil Science, College of Agriculture, Jawahar Lal Nehru Krishi Vishwa Vidyalaya, Jabalpur for providing the facilities for this investigation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Anonymous, Data bank of crop unit-I, crop division, Govt. of India, ministry of agriculture & farmer welfare, department of agriculture, cooperation & farmer welfare; 2020.
2. Anonymous, Farmer welfare and agriculture development department, Madhya Pradesh, In Assistance with the Ministry of Agriculture, Government of India; 2019-20.
3. Gharpinde B, Gabhane VV, Nagdeve MB, Sonune B A, Ganvir MM. Effect of integrated nutrient management on soil fertility, nutrient balance, productivity and economics of soybean in an Inceptisol of semi-arid region of Maharashtra. Karnataka J. Agric. Sci. 2014;27(3): 303-307.
4. Devi KN, Singh TB, Athokpam HS, Singh NB, Shamurailatpam D. Influence of inorganic, biological and organic manures on nodulation and yield of soybean (*Glycine max* Merril L.) and soil properties. Austra. J. Crop Sci. 2013;7(9):1407-1415.
5. Dwivedi AK, Dwivedi BS. Impact of long term fertilizer management for sustainable soil health and crop productivity: Issues and challenges. JNKVV Research Journal. 2015; 49(3):387-397.
6. Dwivedi AK, Singh M, Kauraw DL, Wanjari RH, Chauhan SS. Research bulletin on impact of fertilizer and manure use for three decades on crop productivity and sustainability and soil quality under Soybean-Wheat system on a Vertisol in Central India. IISS. 2007, 224-235.
7. Gomez KA and Gomez AA. Statistical procedures for agricultural research- Hand Book. John Willy & Sons, New York; 1984.
8. Tanwar SPS, Shaktawat MS. Integrated phosphorus management in soybean–wheat cropping system in southern Rajasthan. Fertilizer News. 2004;49(8):25-28.
9. Rathiya PS, Lakpale R. Effect of integrated nutrient management and spatial arrangement on growth and yield of hybrid cotton and soybean under intercropping system. Soybean Research. 2005;3:68-72.

10. Senthivelu M, Prabha ACS. Studies on yield attributes, yield and economics of wet seeded rice under integrated nutrient management practices. International Journal of Plant Science – Muzaffarnagar. 2007;2(2):14-18.
11. Maheshbabu HM, Hunje R, Patil NKB, Babalad HB. Effect of organic manures on plant growth, seed yield and quality of soybean. Karnataka J. Agric. Sci. 2008; 21(2):219-221.
12. Chiezey UF, Odunze AC. Soybean response to application of poultry manure and phosphorus fertilizer in the sub-humid Savanna of Nigeria. Journal of Ecology and Natural Environment. 2009;1(2):25-31.
13. Khaim S, Chowdhury MAH, Saha BK. Organic and inorganic fertilization on the yield and quality of soybean. Journal of Bangladesh Agri. Univ. 2013;11(1):23-28.
14. Hekmat AW, Mohammmadi NK, Nagaraju. Effect of organic and inorganic fertilizer on growth, yield and economic of soybean under rainfed condition. Qalam Academic Research Journal. 2017;5(2).
15. Kundu S, Bhattacharyya R, Prakash V, Gupta HS, Pathak H, Ladha JK. Long-term yield trend and sustainability of rainfed soybean–wheat system through farmyard manure application in a sandy loam soil of the Indian Himalayas, Biol Fertil Soils. 2007;43: 271–280.
16. Bandyopadhyay KK, Misra AK, Ghosh PK, Hati KM. Effect of integrated use of farmyard manure and chemical fertilizers on soil physical properties and productivity of soybean. Soil and Tillage Research. 2010;110(1):115-125.
17. Bhattacharyya R, Pandey SC, Chandra S, Kundu S, Saha S, Mina BL, Srivastava AK, Gupta HS. Fertilization effects on yield sustainability and soil properties under irrigated wheat-soybean rotation of an Indian Himalayan upper valley. Nutr cycl Agroecosyst. 2010;86:255-268.
18. Nagwanshi A, Dwivedi AK, Dwivedi BS and Dwivedi SK. Effect of long-term application of fertilizers and manure on leaf area index, nodulation and yield of soybean in a Vertisol. Journal of Pharmacognosy and Phytochemistry. 2018;7(4):1962-1965.
19. Hekmat AW, Ahmadzai Z, Nagaraju, Hikmat AJ. Influence of integrated use of organic manure and inorganic fertilizer on the growth, and yield, of soybean and nutrient content in soil and plant grown under rainfed condition. International Journal of Applied Research. 2019;5(7): 302-310.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/91798