International Journal of Plant & Soil Science

Volume 35, Issue 13, Page 102-108, 2023; Article no.IJPSS.99610
ISSN: 2320-7035

Effect of Boron and Panchagavya on Growth and Yield of Baby Corn (*Zea mays* L.)

Chanshim Molung Kanshouwa [a++*] and Biswarup Mehera [a#]

[a] *Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj - 211007, Uttar Pradesh, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i132993

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/99610

Original Research Article

Received: 26/02/2023
Accepted: 29/04/2023
Published: 18/05/2023

ABSTRACT

The experiment was conducted in the Crop Research Farm, department of agronomy during the summer season of 2022 on baby corn crop. The treatments consisted of 3 levels of boron (2kg, 3kg, 4 kg/ha) and Panchagavya (2 sprays of 2%, 3%, 4%) as a foliar spray at 15 and 30 DAS and a control. The experiment was laid out in Randomized Block Design (RBD) with 10 treatments and replicated thrice. Application of Boron (4 kg/ha) and Panchagavya (2 sprays of 4%) produced maximum plant height (135.44 cm), plant dry weight (138.95 g), number of cobs per plant (3.06), weight of cobs with husk (44.85g), weight of cobs without cob (8.24g), cob yield with husk (7.48 t/ha), cob yield without husk (3.01 t/ha), green fodder yield (41.80 t/ha). Treatment combination with Boron 4 kg/ha and Panchagavya 2 sprays of 4% produced highest gross returns (Rs. 1,44,700/ha), net returns (Rs. 99,845/ha) and benefit cost ratio (2.23) when compared to control (RDF).

[++] *M.Sc. Scholar;*
[#] *Dean;*
**Corresponding author: E-mail: ckanshouwa@gmail.com;*

Keywords: Boron; panchagavya; baby corn; economic; yield.

1. INTRODUCTION

Baby corn is an ear of maize (*Zea mays* L.) that has been harvested when it is still young, typically before the silks have fully emerged or have just begun. Its botanical name is *Zea mays* L. belonging to the family Gramineae, sub family Poaceae and chromosome number is 2n=20. Although baby corn can be cultivated in a variety of agro climatic settings, the plants thrive and show their greatest potential biomass at temperatures between 25 and 35^0C. Baby corn can be produced on a range of soil types, deep, fertile, rich in organic matter but well- drained soils are the most desirable ones for the crop. In general, irrigation is not needed for kharif crops. Baby corn need to be detasseled before it flowers. Detasseling prevents fertilization and facilitates harvesting later, resulting in an increase in the quantity of cobs with better development.

The majority of baby corn is consumed in Asian nations. Thailand, China, and Taiwan are Asia's top producers of baby corn. Due to its high demand, promising market, chances for value addition, and high earning potential, it is attracting growers' interest in India, much like it has in other Asian nations. Crude protein, phosphorus, potassium, calcium, sugars, ascorbic acid, and crude fiber levels are all abundant in baby corn. Both fresh and processed ingestion of baby corn are options. In addition to the primary crop, it also produces a sizable amount of high-quality green fodder, which serves as a valuable by-product for cattle feed. Consequently, growing baby corn offers a chance to keep a dairy farm running.

Panchagavya, a natural, eco-friendly remedy made from cow by-products. The ingredients used to make these liquid organic solutions include cow dung, urine, milk, curd, ghee, bean flour, and jaggery. With certain adjustments, some farmers are now using this ancient Panchagavya formulation in organic farming [1]. Few farmers in India's southern states have experimented with modified Panchagavya formulations and discovered that they improve the biological efficiency of field crops as well as the quality of fruits and vegetables [2]. “Panchagavya includes growth regulators like IAA, GA, and Cytokinin, as well as essential plant nutrient and beneficial microbes like Lactic Acid Bacteria, Yeast, and Actinomycetes” [3]. “Higher populations of bacteria actinomycetes phosphate solubilizers fluorescent pseudomonads, nitrifiers, dehydrogenase activity and microbial biomass carbon were found in Panchagavya” [4].

Boron is an important micronutrient for healthy plant growth and development. Numerous plant processes, including sugar transport, cell wall synthesis, lignification, meristematic tissue cell division, formation of petal and leaf buds, cell wall integrity, ribonucleic acid (RNA) metabolism, respiration, indole acetic acid (IAA) metabolism, cytokinin production and transfer, phenol metabolism, nitrogen fixation, pollen germination, pollen tube formation, and seed formation, depend on it. Cell wall strength and development, cell wall division, fruit and seed development, sugar transport, and hormone development are all related to the principal functions of boron. Gay Lussac and Thenard, [5] discover “Boron and state that it plays an important role in plant growth and development”. “Boron is one of the essential nutrients for the optimum growth, development, yield, and quality of crops” [6] “Boron strengthened the cell wall and development, cell division, fruit and seed development and development of hormone” [7]. A Lack of boron hinders blooming and fruiting. It also delays the processes of pollen germination and pollen tube development [8]. “Boron deficiency inhibits root elongation through limiting cell enlargement and cell division in the growing zone of root tips” [9]. Plants require minimal amounts of boron, although most plants become hazardous at levels of 20 ppm or more [10].

2. MATERIALS AND METHODS

2.1 Field Location and Soil Status

A field experiment was conducted during July-September (2022) to study the effect of boron and foliar spray of panchagavya on growth, yield and economics of Baby corn at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture Technology and Sciences. The Crop Research Farm is situated at 25.77^0 North latitude, 81.50^0 East longitude and 98 m altitude from the sea level. This area is situated on the right side of the river Yamuna by the side of Prayagraj Rewa road about 5 km away from prayagraj city. The soil of the experimental field was sandy loam in texture,

nearly neutral in soil reaction (pH 7.6), organic carbon level in medium condition (0.87%), medium available N (225 kg/ha), high in available P (41.8 kg/ha) and medium available K (261.2 kg/ha).

2.2 Treatment Details

The experiment was laid out in a Randomized Block Design with ten treatments and three replications. The treatments included in the study were T_1- Boron (2 kg/ha) + Panchagavya (2 sprays of 2%), T_2- Boron (2 kg/ha) + Panchagavya (2 sprays of 3%), T_3- Boron (2 kg/ha) + Panchagavya (2 sprays of 4%), T_4- Boron (3 kg/ha) + Panchagavya (2 sprays of 2%), T_5- Boron (3 kg/ha) + Panchagavya (2 sprays of 3%), T_6- Boron (3 kg/ha + Panchagavya (2 sprays of 4%), T_7- Boron (4 kg/ha) + Panchagavya (2 sprays of 2%), T_8- Boron (4 kg/ha) + Panchagavya (2 sprays of 3%), T_9- Boron (4 kg/ha) + Panchagavya (2 sprays of 4%) and T_{10}- Control (120: 60:40 NPK kg/ha). As per requirements and in order during the crop period, agronomic practices are followed. Random sampling technique was used throughout the experiment to record observations on the different morphological characteristics of the plant. Pre-harvest (related to growth attributes) and post-harvest (relating to yield attributes, quality parameter, soil parameter, and economics) observations were made often, and each of these categories was evaluated separately. Experimental data collected was subjected to statistical analysis by adopting Fisher's method of analysis of variance (ANOVA) as outlined by Gomez and Gomez (1984). Critical Difference (CD) values were calculated wherever the 'F' test was found significant at 5 percent level.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Plant height (cm)

Maximum plant height of Baby corn at harvesting stage was recorded (135.44 cm) with the application of T_9- Boron (4 kg/ha) + Panchagavya (4% of 2 sprays) (Table 1) which was significantly superior over rest of the treatments and remained at par with application of boron (3 kg/ha) + Panchagavya (2 sprays of 4 %) (134.07). Panchgavya boost the creation of new cells, increase plant vigor, and speed up the development of leaves, all of which aid in capturing more solar energy and better utilization of nitrogen for higher growth qualities. Similar results were also found by Kumar et al. [11] and (Vimalendran, Wahab [12]. The significant effect of panchagavya was mainly attributed to its nutrient content, higher biological activity and presence of plant growth promoting substances where apical meristem's activity has a major role in determining the growth and development of the plant's above-ground components and elongates the stem, which was confirmed by Hazarika et al. [13].

3.1.2 Dry weight (g/plant)

Maximum dry weight of baby corn at harvest was recorded at (69.80 g) with the application of T_9- Boron (4 kg/ha) + Panchagavya (4% of 2 sprays) (Table 1). In panchagavya, the hormonal substance particularly cytokinin plays an important role in nutrient partitioning in vegetative plant parts. Panchagavya promotes the synthesis of chemicals IAA and GA3 which might have stimulated the production of growth regulators in the cell system, which led to an increase in growth. "Improved nutrition may enable greater leaf area production that results in greater interception of light thereby increasing dry matter production" De Britto and Girija [14].

3.1.3 Crop growth rate (g/m^2/day)

The crop growth rate (CGR) (g/m^2/day) of Baby corn between 15-30 DAS, 30-45 DAS and 45-60 DAS was recorded non-significantly maximum (13.34, 24.76 and 14.96 g/m2/day) with the application of T_9- Boron (4 kg/ha) + Panchagavya (4% of 2 sprays) (Table 1).

3.1.4 Relative growth rate (g/g/day)

The relative growth rate (RGR) (g/g/day) of Baby corn between 15-30 DAS, 30-45 DAS and 45-60 DAS was recorded non-significantly maximum (0.034, 0.024 and 0.016 g/g/day) with the application of T_9- Boron (4 kg/ha) + Panchagavya (4% of 2 sprays) (Table 1).

3.2 Yield and Yield Attributes

3.2.1 No. of cobs per plant

Number of cobs per plant failed to touch the level of significance from various treatments (Table 2). Similar findings were found in Khan et al. [15].

Table 1. Growth attributes of baby corn as influenced by boron and panchagavya

Treatments	Growth attributes							
	Plant height (cm)	Dry weight (g/plant)	CGR(g/m^2/day)			RGR(g/g/day)		
			15-30 DAS	30-45 DAS	45-60 DAS	15-30 DAS	30-45 DAS	45-60 DAS
Boron (2 kg/ha) + Panchagavya (2 sprays of 2%)	105.18	60.83	7.29	9.75	12.75	0.030	0.018	0.014
Boron (2 kg/ha) + Panchagavya (2 sprays of 3%)	106.07	75.20	8.75	13.61	15.36	0.033	0.021	0.013
Boron (2 kg/ha) + Panchagavya (2 sprays of 4%)	125.14	97.91	10.04	16.73	22.26	0.031	0.021	0.015
Boron (3 kg/ha) + Panchagavya (2 sprays of 2%)	123.06	102.87	12.79	18.59	20.11	0.034	0.020	0.013
Boron (3 kg/ha) + Panchagavya (2 sprays of 3%)	117.43	93.49	8.54	17.70	21.07	0.030	0.021	0.015
Boron (3 kg/ha) + Panchagavya (2 sprays of 4%)	134.07	115.84	12.53	21.86	24.32	0.034	0.023	0.014
Boron (4 kg/ha) + Panchagavya (2 sprays of 2%)	124.84	113.19	12.24	21.93	23.08	0.034	0.023	0.013
Boron (4 kg/ha) + Panchagavya (2 sprays of 3%)	125.61	117.49	13.10	21.08	25.34	0.035	0.022	0.014
Boron (4 kg/ha) + Panchagavya (2 sprays of 4%)	135.44	138.95	13.34	24.76	33.33	0.035	0.024	0.016
Control (120: 60:40 NPK kg/ha)	119.28	69.80	7.65	11.49	14.96	0.029	0.019	0.014
SEm(±)	2.53	1.20	0.29	0.57	0.92	0.0009	0.00067	0.00063
CD(p=0.05)	5.33	3.57	0.86	1.72	NS	0.0028	0.00201	NS

Table 2. Yield and yield attributes of baby corn as influenced by boron and panchagavya

Treatments	Yield and yield attributes					
	No. of Cobsper plant	Cob weight with husk (g)	Cob weight without husk (g)	Cob yield with husk (t/ha)	Cob yield without husk (t/ha)	Green fodder yield (t/ha)
Boron (2 kg/ha) + Panchagavya (2 sprays of 2%)	1.73	31.65	4.44	4.32	1.47	18.40
Boron (2 kg/ha) + Panchagavya (2 sprays of 3%)	1.8	31.89	5.58	4.86	1.63	24
Boron (2 kg/ha) + Panchagavya (2 sprays of 4%)	1.86	31.02	5.71	5.54	1.98	32.30
Boron (3 kg/ha) + Panchagavya (2 sprays of 2%)	1.93	35.57	5.16	5.01	1.54	23.90
Boron (3 kg/ha) + Panchagavya (2 spraysof 3%)	2	35.61	5.59	5.24	1.67	26.70
Boron (3 kg/ha) + Panchagavya (2 sprays of 4%)	2.20	42.29	6.89	6.98	2.91	40.70
Boron (4 kg/ha) + Panchagavya (2 sprays of 2%)	2.13	44.34	7.59	6.13	2.65	33.40
Boron (4 kg/ha) + Panchagavya (2 sprays of 3%)	2.06	39.21	6.31	6.31	2.78	38.30
Boron (4 kg/ha) + Panchagavya (2 sprays of 4%)	3.06	44.85	8.24	7.48	3.01	41.80
Control (120: 60:40 NPK kg/ha)	1.6	32.91	5.27	5.34	1.95	31.40
SEm(±)	0.18	2.09	0.27	0.57	0.17	2.95
CD(p=0.05)	NS	6.23	0.79	1.69	0.51	8.77

3.2.2 Cob weight with husk (g)

Maximum cob weight with husk was recorded significant at (44.85 g) with the application of T_9 - Boron (4 kg/ha) + Panchagavya (4% of 2 sprays) (Table 2). The microorganisms present in panchagavya established in the soil improved the sustainability of agriculture, and the rhizosphere environment around the roots enhanced the plant growth, enhanced flowering, increased fruit and crop yield [16] and [17]**.**

3.2.3 Cob weight without husk (g)

Maximum cob weight without husk was found significant at (8.24 g) with the application of T_9 - Boron (4 kg/ha) + Panchagavya (4% of 2 sprays) (Table 2). Application of boron activates the enzyme, membrane integrity, chlorophyll formation, stomatal balance and starch utilization at early stages enhances grain filling [18]. Boron enhances grain yield and reduce partly grain-free ear in corn Ziaeyan et al. [19].

3.2.4 Cob yield with husk (t/ha)

Maximum cob yield with husk was found significant at (7.48 t/ha) with the application of T_9 - Boron (4 kg/ha) + Panchagavya (4% of 2 sprays) (Table 2). However boron (4 kg/ha) + Panchagavya (2 sprays of 2%) (44.34 g), boron (3 kg/ha) + Panchagavya (2 sprays of 4%) (42.29 g), and boron (4 kg/ha) + Panchagavya (2 sprays of 3%) (39.21 g) was statistically at par with boron (4 kg/ha) + Panchagavya (2 sprays of 4%). “Boron is important for metabolism of carbohydrate and translocation and also plays a vital role in materialization of cell in plants, pollen tube growth, integrity of plasma membranes, and encouragement fertilization for seed development” Ceyhan [20].

3.2.5 Cob yield without husk (t/ha)

Maximum cob yield without husk was found significant at (3.01 t/ha) with the application of T_9 - Boron (4 kg/ha) + Panchagavya (4% of 2 sprays) (Table 2). However boron (4 kg/ha) + Panchagavya (2 sprays of 2%) (7.59 g) was statistically at par with boron (4 kg/ha) + Panchagavya (2 sprays of 4%). The application of panchagavya result in higher fruit yield due to the enhancement of nutrient availability uptake by the plants and fruit yield is closely related to the physiological attributes like leaf area, chlorophyll content and dry matter production [21].

3.2.6 Green fodder yield (t/ha)

Maximum green fodder yield was found significant at (41.80 t/ha) with the application of T_9 - Boron (4 kg/ha) + Panchagavya (4% of 2 sprays) (Table 2). However boron (3 kg/ha) + Panchagavya (2 sprays of 4%) (6.98 g), boron (4 kg/ha) + Panchagavya (2 sprays of 3%) (6.31 g), boron (4 kg/ha) + Panchagavya (2 sprays of 2%) (6.13 g) was statistically at par with boron (4 kg/ha) + Panchagavya (2 sprays of 4%). The above result might be attributed due to the fact that the presence of Boron increase photosynthesis, which is indicative of how the micronutrients help to activate the synthesis of tryptophan and the precursor to IAA and is responsible for stimulating plant growth and biomass accumulation, the maximum plant height and greater number of leaves were observed in this treatment. Similar results were also reported by Satybhan et al. 2019.

3.3 Economics

3.3.1 Cost of cultivation

The maximum cost of cultivation (Rs 44,855/ha) was recorded with the application of treatment T_9 - Boron (4 kg/ha) + Panchagavya (2 sprays OF 4%) (Table 3). It may be attributed due to the increasing prices of Boron, Panchagavya and labour cost.

3.3.2 Gross return

The maximum gross return (Rs 1,44,700/ha) was found with the application of treatment T_9 - Boron (4 kg/ha) + Panchagavya (2 sprays OF 4%) (Table 3). It may be attributed due to maximum cob yield and green fodder yield was found over the other treatments.

3.3.3 Net return

The maximum net return (Rs 99,845/ha) was recorded with the application of treatment T_9 - Boron (4 kg/ha) + Panchagavya (2 sprays OF 4%) (Table 3). It is attributed due to the highest gross return found in the mentioned treatment.

3.3.4 Benefit cost ratio

Maximum benefit cost ratio (B:C) (2.23) was recorded with the application of T_9 - Boron (4 kg/ha) + Panchagavya (2 sprays OF 4%) (Table 3). It is attributed to maximum output and low input. Similar results were reported by Somasundaram [22] in maize [23].

Table 3. Economics of baby corn cultivation as influenced by boron and panchagavya

Treatments	Economics			
	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio
Boron (2 kg/ha) + Panchagavya (2 sprays of 2%)	42,919	89,200	46,281	1.08
Boron (2 kg/ha) + Panchagavya (2 sprays of 3%)	43,167	93,800	50,633	1.17
Boron (2 kg/ha) + Panchagavya (2 sprays of 4%)	43,415	1,15,800	72,385	1.67
Boron (3 kg/ha) + Panchagavya (2 sprays of 2%)	43,639	99,400	55,761	1.28
Boron (3 kg/ha) + Panchagavya (2 sprays of 3%)	43,887	1,02,200	58,313	1.33
Boron (3 kg/ha) + Panchagavya (2 sprays of 4%)	44,135	1,40,100	95,965	2.17
Boron (4 kg/ha) + Panchagavya (2 sprays of 2%)	44,359	1,16,700	72,341	1.63
Boron (4 kg/ha) + Panchagavya (2 sprays of 3%)	44,608	1,30,200	85,592	1.92
Boron (4 kg/ha) + Panchagavya (2 sprays of 4%)	44,855	1,44,700	99,845	2.23
Control (120: 60:40 NPK kg/ha)	40,983	1,01,100	60,0117	1.47

4. CONCLUSION

The results of this study indicated that use of various levels of boron and panchagavya improved the growth parameters, yield and economics. However among the treatment, application of treatment 9, Boron 4kg/ha with two sprays of four percent panchagavya at 15 and 30 days after sowing was found to have profound effect on growth and yield resulting in higher growth parameters, yield attributes and economics in Baby corn. Since the findings are based on the research done in one season, the experiment may be repeated for confirmation.

ACKNOWLEDGEMENT

The authors are thankful to Department of Agronomy, Naini Agricultural Institute, Prayagraj, Sam Higginbottom University of Agriculture Technology and Sciences, (U.P) India for providing necessary facilities to undertake the studies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Natarajan K. Panchagavya-a manual, Other India Press, Mapusa, Goa, India. 2002:33.
2. Vallimayil J, Sekar R. Investigation on the effect of panchagavya on Sounthern Sunnhemp Mosaic Virus (SSMV) infected plant systems. Global Journal of Environmental Research. 2012;6(2):75-79.
3. Venkatalakshmi K, Balasubramanian A, Sankaran N. Influence of seed treatment and foliar spray of panchagavya on growth, yield attributes and yield of *Amaranthus viride*. Madras Agricultural Journal. 2009;96(1-6):135-138.
4. Amalraj DL, Kumar GP, Ahmed SKM, Kishore. Microbiological analysis of panchagavya, vermicompost, and FYM and their effect on plant growth promotion of pigeon pea (*Cajanus cajan* L.) in India. Organic Agriculture. 2013;3(1):23-29.
5. Gay L, Thenard. A history of chemistry. 1808:77-98.
6. Brown PH, Bellaloui N, Wimmer MA, Bassil ES, Ruiz J, Hu H. Boron in plant biology. Plant Biology. 2002;4:205-223.
7. Ahmad W, Niaz A, Kanwal S, Rahmatullah Rasheed MK. Role of boron in plant growth: A review. Journal of Agriculture Research. 2009;47:329-338.
8. Muntean DW. Boron, the overlooked essential element. Soil and Plant Laboratory Inc., Bellevue, WA98009. P.O Box 1648; 2009.
9. Dell B, Huang L. Physiological response of plants to low boron. Journal Plant Soil. 1997;193:103-120.
10. Carlos B. Effects of boron on plants. Nevada's Horticulture Connection, University of Nevada Cooperative Extension. 2000;1(1).
11. Kumar MV, Velayutham A, Kumar NS, Vasanthi D. Influence of different organic manures on the growth and yield of Baby corn. International Journal of Advanced Agricultural Science and Technology. 2018;7(5):167-174.
12. Vimalendran L, Wahab K. Influence of panchagavya foliar spray on the growth attributes and yield of baby corn

(*Zea mays* L.) cv. COBC 1. Journal of Applied and Natural Science. 2014;6(2).

13. Hazarika UK, Munda GC, Bujorboruah KM, Das A, Patel DP, Prasad K, Rajeshkumar Danwar AS, Tomar JMS, Bordoloi J, Sharma M, Girin G. Components of nutrient management. Nutrient Management Organic Farming. 2006:15-53.
14. De Britto JA, Girija SL. Investigation on the effect of organic and inorganic farming methods on blackgram and greengram. Indian Journal of Agricultural Research. 2006;40(3):204-207.
15. Khan HZ, Malik MA, Saleem MF. Effect of rate and source of organic material on the production potential of spring maize (*Zea mays* L.). Pakistan Journal Agriculture Science. 2008;45(1).
16. Beaulah A. Growth and development of moringa (*Moringa oleifera* Lam.) under organic and inorganic systems of culture. International Journal of Advanced Science and Research Univ, Coimbatore. 2001;57.
17. Yadhav BK, Christopher Lourduraj A. Effect of organic manures and panchagavya spray on yield attributes, yield and economics of maize (*Zea mays* L.). Journals of Crop Research. 2006; 30(1):1-5.
18. Asif M, Saleem SA, Anjum MA, Bilal MF. Effect of nitrogen and Application of element boron some agronomic traits of corn (*Zea mays* L.) hybrids. Journal of Biological Response. 2013;4(3):37-40.
19. Ziaeyan AH, Rajaie M. Combined effect of zinc and boron on yield and nutrients accumulation in corn. International Journal of Plant Production. 2009;3:33-45.
20. Ceyhan C, Onder D, Ozturk O, kaya MH, Hamurcu M. Effects of boron on growth and yield of maize (*Zea mays* L.). Journal Agricultural Research. 2008;51(4):114–256.
21. Sanjutha S, Subramanian S, Rani I, Maheswari J. Integrated nutrient Management in Kalmegh. Research Journal of Agricultural and Biological Sciences. 2008; 4(2):141-145.
22. Somasundaram E. Evaluation of organic sources of nutrients and panchagavya spray on the growth and productivity of maize sunflower-greengram system. Thesis submitted to Tamil Nadu Agricultural University, Coimbatore for award of Ph. D. degree; 2003.
23. Ceyhan E, Onder M, Harmankaya M, Hamurcu M, Gezgin S. Response of chickpea cultivars to application of boron in borondeficient calcareous soils. Commun. Soil Sci. Plant Anal. 2007;38:2381-2399.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/99610