



A Low-Cost Assembly for Extraction of Hot Calcium Chloride Extractable Boron from Soil Samples

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Among micronutrients, boron (B) occupies a prime place next to zinc (Zn) in Indian Agriculture. Acidic soils, coarse-textured soils subjected to leaching in high rainfall areas, and calcareous soils are likely to be deficient in B (Srivastava and Gupta 1996). According to an estimate based on soil testing of more than two lakh samples drawn from 508 districts of India indicated that 23.2 per cent of soil samples are deficient in B (Shukla *et al.* 2019). Though there are several methods for the analysis of B in soils yet hot water-soluble B (Berger and Truog 1940; Gupta 1967) or dilute CaCl_2 extractable B (Cartwright *et al.* 1983; Adams *et al.* 1991) are widely adopted for different soils all over the World (Diana 2008). The assembly adopted for the extraction of hot water soluble or dilute CaCl_2 extractable B is costly as it requires the use of low B glass or quartz boiling flask equipped with a condenser tube for refluxing (Parker and Gardner 1981) which generally poses difficulty in handling and maintenance. Schuppli (1986) used a Teflon Erlenmeyer flask (125 ml) capacity attached to a Teflon reflux condenser to extract hot water-soluble B from soils, and an asbestos mat was placed between the hot plate and the flask to prevent damage to the Teflon flask. This publication proposes a low-cost assembly to extract hot water-soluble or hot CaCl_2 extractable B in soils.

The requirements of the proposed assembly meant for the extraction of hot water soluble or calcium chloride extractable B in soils were, a long-form beakless low B glass or quartz beaker (15.0 cm long with an internal diameter of 8.5 cm, 500 mL capacity) and a

low B glass or quartz basin (100 mL capacity with an outer diameter of 8.7 cm) closely fitting to the circumference of quartz beaker which were procured from M/s Jain Scientific and Glass Works, Ambala Cantt., and an electric hot plate (60 cm × 45 cm).

Five bulk surface (0-15 cm) soil samples were collected from experimental plots of the Crop Research Centre of the G.B Pant University. The experimental area is located at 29°01.450' N latitude and 79°28.723' E longitude at 243.8 m above the MSL. The climate is humid subtropical with hot summer (mean temperature 29 to 32°C) and cold winter (mean temperature 13 to 15°C). Rainfall ranges from 1300 to 1500 mm per annum, of which 80 to 90 per cent occurs during monsoon season, starting from mid-June to September. The experimental area had sandy loam to loam texture (Typic Hapludolls), 6.5 to 6.7 pH; 0.312 to 0.372 dSm^{-1} electrical conductivity in 1:2 soil water suspension, 10.05 to 11.42 g organic C kg^{-1} soil. Each soil sample was air-dried under shade, crushed and sieved through a 2 mm sieve. Homogenized soil samples were stored in plastic bags.

Ten-gram air-dry soil of each bulk sample was weighed and placed in a long-form beakless low B glass or quartz beaker, and 20 mL of 0.01 M CaCl_2 solution was added to the beaker. To each sample, 0.5 g phosphorus-free- activated charcoal powder was also added to the beaker. The long-form beaker was covered by a low B glass or quartz basin (100 mL capacity) filled with 85 mL cold distilled water. The long-form beaker containing soil suspension covered by a water-filled basin was placed on the hot plate. The basic setup of hot water-soluble B

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extraction assembly is shown in fig. 1. The gentle boiling of the contents for 5 minutes was counted after the initiation of boiling in the beaker. The vapours generated from the contents touched the bottom of the basin and get condensed. After 5 minutes of the gentle boiling, the whole assembly (long-form beaker with water-filled basin) was removed from hot plate and placed on the tabletop for cooling and further condensation of the remaining vapours. The extraction procedure was done in triplicate for each soil sample. After cooling, the contents were filtered in a plastic vial for analysis of B by the Azomethine-H method as outlined by Tandon (2005). The mean, standard deviation ($\pm\sigma$) and coefficient of variation were computed for each soil sample.

Soil extracts obtained in the present study with the use of 0.5 g charcoal powder were colourless as the soil organic matter contents in these soil samples were below 3 per cent (Gupta 1979). The analytical results obtained for different soil samples (n =5) using the above described assembly showed that the magnitude of standard deviation for triplicate analysis varied from 0.01 to 0.08 mg B kg⁻¹ soil (Table 1). The coefficient of variation varied from 1.05 to 5.49 per cent. This indicated a relatively good precision of the extraction using the low-cost B extraction assembly. Schuppli (1986) also observed that the coefficients of variation in the analysis of hot water-soluble B without and with correction for background colour were 5.2 and 7.5 percent, respectively.

The analytical values of hot calcium chloride

Table 1. The mean, standard deviation and coefficient of variation in 0.01 M CaCl₂ extractable B content in soil samples extracted by using the low cost assembly.

Sample	Mean of three replications	Standard deviation ($\pm\sigma$)	Coefficient of variation (%)
1	0.58	0.07	1.23
2	0.70	0.04	5.49
3	0.78	0.08	1.05
4	0.90	0.03	3.14
5	0.33	0.01	2.89

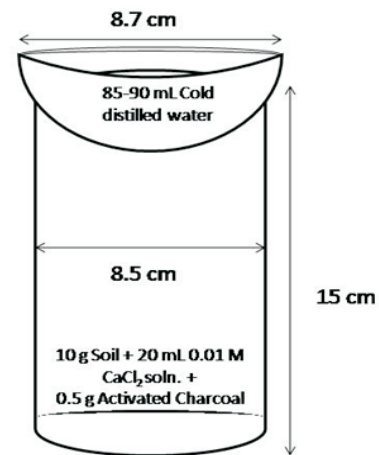


Fig. 1. A schematic sketch of low cost hot 0.01 M CaCl₂ soluble B extraction assembly.

extractable soil B obtained using the proposed low-cost extraction unit showed low standard deviation and coefficient of variation for extractable B, proving the unit's suitability in the routine soil testing. The proposed extraction unit can handle at least 10-12 samples on an electrical hot plate to ultimately enhance the chemical analyses output in a soil testing laboratory. The proposed unit is easy to handle, and the cleaning of the extraction beaker is also much easier as compared to that of a boiling flask with a condenser.

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Received: May, 2020

Accepted: November, 2020