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Original Research Article

Comparative mineral uptake potential of some exotic weeds from family Asteraceae

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Mineral analysis, Exotic weed, Macronutrient, Micronutrient, *Bidens biternata*, *Conyza bonariansis*, *Eupatorium adenophorum*

A B S T R A C T

Weeds are unwanted plants but some weeds have ethnic value, and used for human betterment. Present study reveals mineral uptake potential of some exotic weeds belonging to Asteraceae. The term exotic is nothing but those are introduced from another country they may become noxious, grow vigorously and difficult to control. The comparisons of the environmental conditions of invasive species in their native and newly colonized habitats are important to address a number of hypotheses concerning the spread of exotic species of family Asteraceae viz. *Bidens biternata* Laor., *Conyza bonariansis* L., *Eupatorium adenophorum* Spreng. and *Xanthium strumarium* L.. Among these exotic weeds it found that in *B. biternata* uptake potential of nitrogen, magnesium, sodium, molybdenum and boron content has well developed. In *C. bonariansis*, phosphorus, zinc, iron and copper uptake potential well developed. In *Eupatorium adenophorum* potassium, calcium, sulphur and manganese and while in *X. strumarium* phosphorus sulphur, copper and boron uptake uptake found well developed.

Introduction

To complete life cycle successively all living organisms including human, other animal and plant also require a continuous supply of large number of substances from outside. This need is fulfilled by nutrition uptake in the form of mineral from soil. The essential nutrients required by higher plants are exclusively of inorganic nature. A plant for normal optimal growth requires sixteen different elements. The growth and productivity of plants is directly related to their mineral nutrient status present in soil. The mineral composition requirement varies among different plant species (Arzani *et al*., 2007). Minerals are essential for human nutrition and that are collected by consumining different plants where they get accumulated maximumly (Ajasa *et al*., 2004). This availability in plant species is controlled by their genetically fixed nutrient uptake potential, the nutrient availability in the soil, and other environmental factors (Mengel and Kirkby, 2001). In the present investigation four different exotic weeds (viz. *Bidens biternata, Conyza bonariansis, Eupatorium adenophorum* and *Xanthium strumarium*) from the Compositae family (Asteraceae) were studied for understanding reason behind their maximum growth than other.

Asteraceae is one of the largest family in the dicotyledons, has been subdivided into18 tribes, some 1300 genera and about 21000 species. While, it is the second largest family comprising weeds. *Bidens biternata* is native to Tropical America. It was weed of waste places and now it occurs in crop field abundantly. The plant has a long history of use among the indigenous people of the Amazon, and virtually all parts of the plant are used as in form of decoctions and paste or poultice for external use. It is commonly used there for hepatitis, conjunctivitis, abscesses, fungal infections, urinary infections, as a weight loss aid, and to stimulate childbirth. Phytochemically, the plant is rich in flavonoids, terpenes, phenolics, lipids, and benzenoids (Sundararajan *et al*., 2006). The second exotic weed *Conyza bonariensis* is native to Australia (Burry and Kloot, 1982). An agricultural and environmental weed, with habitat preferences for disturbed sites, abandoned fields and roadsides. It is erect herbs, heads terminal, dichotomous, corolla white or yellow.

Eupatorium adenophorum has syn. *Ageratina adenophora,* is originating from Central America in Mexico. Presently it appeared as a major weed in several areas in different parts of the world including India. It is a perennial semi shrubby herbaceous plant with a woody stem basis in older plants. The plant releases a carrot like odour when broken, and all parts of the plant are poisonous to cattle (Gosper, 2003). Leaves are triangular, crenate-serrate. Inflorescence head in dense clusters, achenes long, angled; pappus white, presently it become cosmopolitan. *Xanthium strumarium* L. is weed maximullay interfere in crops like corn, cotton, peanuts and soybeans. It is extremely competitive is a native of North America (Tranel and Wassom, 2001). It is annual weed of waste lands. It is erect, stem has rough short hairs, leaves broadly ovate to cordate, crowded at the top of the stem.

Materials and Methods

Various inorganic constituents like Na^{+}, K^{+}, P^{5+}, Mg^{2+}, Fe^{3+}, Mn^{2+}, Ca^{2+}, Cu^{2+}, Zn^{2+} were estimated from the leaves of compositae members (viz. *Bidens biternata, Conyza bonariansis, Eupatorium adenophorum* and *Xanthium strumarium*). The leaves of these exotic weeds were collected separately from a healthy population washed, blotted to dryness, slowly oven dried and powdered 0.5 g of sample was acid digested following the standard method of Toth *et al.* (1948). Total nitrogen content in leaves was estimated following the method given by Hawk *et al.* (1948). The nitrate contents were determined using rapid colorimetric method by nitration of salicylic acid Cataldo *et al.* (1975).

Results and Discussion

Comparative mineral analysis of four exotic weeds was investigated to determine their nutritional potential for livestock. Present investigation carried out to know why these weeds become cosmopolitan in India. Generally weeds grows rapidly in polluted area. Green plants have comparatively simple nutrient requirements and these are classified as macronutrients (N, P, K, Ca, Mg, S, and Na) and micronutrients (Zn, Fe, Cu, Mn, Mo and B). Both are essential for almost all metabolic processes. The mineral nutrition is an important aspect of plant growth that governs the productivity of living organisms. The nutrient compositions uptakes in leaves of four weeds are depicted in Table.1.

Macronutrient uptake

Nitrogen

Among all the mineral nutrients nitrogen is very essential for synthesis of many organic compounds, some components of nucleic acids, proteins, hormones, coenzymes and chlorophylls. A large part of the plant body is composed of N-containing compounds. Deficiency of N shows symptoms like stunted growth, light green older leaves, older leaves becomes yellow and die (chlorosis) (Williams, 1992). According to Gallacher and Sprent (1978) total nitrogen content in plant reflects total plant growth. In this study highest nitrogen uptake (1.93 %) was observed in leaves of *B. biternata* followed by *C. bonariansis* (1.34 %), *E. adenophorum* (1 %) and *X. strumarium* (0.95 %). Higher nitrate content indicates increase in toxicity in plant species. Here in present investigation highest nitrate accumulation (0.055 %) was observed in leaves of *E. adenophorum*, followed by *B. biternata* (0.051 %), *X. strumarium* (0.049 %) and *C. bonariansis* (0.048%).

Phosphorus

Phosphorus is a major nutrient for a plant which is important for plant growth and metabolism. It plays a key role in photosynthesis, respiration, and the regulation of enzymes (Raghothama, 1999). The maximum amount of P (2.5 %) was observed in *C. bonariansis* followed by *X. strumarium* (1.17 %), *B. biternata* (1.12 %) and *E. adenophorum* (1.01 %).

Potassium

According to Epstein (1972) Potassium is indispensable for plant growth. It's requirement is 1% potassium for their optimal growth. It also plays a significant role in plant growth and developmental processes such as photosynthesis, translocation of proteins and carbohydrates, stability of ribosomes, protein synthesis, nitrogen turnover, carbohydrate metabolism, glycolysis, phosphorylation and adenine biosynthesis in plants (Marschner, 1986). The higher concentration of K (1.15%) was observed in *E. adenophorum*, the moderate but lower than optimal concentration was observed in *B. biternata* (0.75 %) and *C. bonariansis* (0.75 %) and the lowest concentration among studied weeds was observed in *X. strumarium* (0.7 %).

Calcium

According to Clark (1984), the activities of many enzymes have been either stimulated or inhibited by calcium. Calcium is also a non- toxic mineral nutrient, even in high concentration and is very effective in detoxifying high concentrations of other mineral elements in plants. It is a component of calcium pectate, a constituent of cell walls. In addition, Ca is a co-factor of certain enzymatic reactions. Recently, it has been determined that Ca is involved in the intimate regulation of cell processes mediated by a molecule called calmodulin

(Ashley *et al*., 2006). It is evidence from result (Table 1) that among all these studied weeds calcium level is very low as compare to other plant. As in *Portulaca oleracea* leaves 4.4 % (dry wt.) calcium was recorded by Karadge, 1981, in the leaves of *Cassia* species 2.57 to 3.37 % (dry wt.) calcium was recorded by Patil (2009) and in different *Cleome* species that is in range of 2.037 to 11%. The large amount of Ca (1.55 %) concentration was observed in *E. adenophorum* followed by *B. biternata* (1.15 %), *C. bonariansis* (1.3 %), *X. strumarium* (0.95 %).

Magnesium

In the plants, 2% Mg on dry weight basis has been regarded as critical value by Epstein (1972). It plays an important role in plant cells since it appears in the center of the chlorophyll molecule. Certain enzymatic reactions require Mg as a co-factor (Hochmuth *et al*., 2004). According to Clark (1984) under some circumstances Mg may contribute to the electrical neutrality of organic compounds such as sugar phosphates, sugar nucleotides and organic as well as amino acids. The higher concentration of Mg (0.54 %) was observed in *B. biternata* followed by *E. adenophorum* (0.43 %), *X. strumarium* (0.31 %) and *C. bonariansis* (0.19 %). Which is very low that per normal optimal requirement.

Sulphur

It is a component of sulfur-containing amino acids such as methionine. Sulfur also is contained in the sulfhydryl group of certain enzymes (Hochmuth *et al*., 2004). The large amount of S (0.15 %) was observed in *E. adenophorum* followed by *X. strumarium* (0.13 %) *B. biternata* (0.12 %) and *C. bonariansis* (0.11 %).

Sodium

Sodium is the principal cation in extracellular fluids. The range of sodium in glycophytes as given by Gauch (1972) is 0.1 to 1.4% dry wt. It regulates acid-base balance, involved in the maintenance of osmotic pressure and cell permeability. It involved in Na+/K+-ATPase, maintenance of membrane potentials, the absorptive processes of monosaccharides, amino acids and pyrimidines. The changes in osmotic pressure are largely dependent on sodium concentration (Malhotra, 1998). Its metabolism is regulated by aldosterone.The more amount of Na (35 %) concentration was observed in *C. bonariansis* followed by *E. adenophorum* (16 %), *B. biternata* (4 %) and *X. strumarium* (3 %). Same kind of results reported in crop plants like sugarcane, 0.11% sodium content by Nimbalkar, (1973) and in finger millet it was 0.09% (Chavan, 1980), in *Portulaca oleracea* (Karadge, 1981) (0.30% dry weight) and in *Cleome* species 0.08 to 0.38% (Aparadh, 2011). It is evident from results (Table.1) that all studied weed species have less uptake potential for sodium.

Micronutrients

Zinc

Zn is an essential component of a number of enzymes present in animal tissue including alcohol dehydrogenase, alkaline phosphatase, carbonic anhydrase and procarboxypeptidase, is also essential for the normal growth and reproduction and helps in the process of tissue repair and wound healing. Zinc deficiency causes growth retardation and skin lesions (Chatterjee and Shinde, 1995). The critical deficiency levels of Zn are below 1.5–2.0 mg 100 g^{-1} dry weight of leaves and critical toxicity levels of zinc in leaves of crop plants are more than 40–50 mg 100 g^{-1} dry weight basis (Marschner, 1986). Zinc is necessary for the growth and multiplication of cells (enzymes responsible for DNA and RNA synthesis), for skin integrity, bone metabolism and functioning of taste and eyesight. (Longnecker and Uren, 1990). Zn is not considered to be highly phytotoxic, but high contents of zinc in plants may cause the loss of leaves production, whereas low contents may cause deformations of leaves. The higher concentration of Zn (110.63 ppm) was observed in *C. bonariansis*, the moderate concentration was observed in *B. biternata* (38.96 ppm) and *E. adenophorum* (38.69 ppm), the lower concentration was observed in *X. strumarium* (50.94 ppm). From these result it can be concluded that *C. bonariansis* weed can survive any environmental condition.

Ferrous

It is used in the biochemical reactions that form chlorophyll and is a part of one of the enzymes that is responsible for the reduction of nitrate-N to ammoniacal-N. Other enzyme systems such as catalase and peroxidase also require Fe. (Hochmuth *et al*., 2004). The adequate value of iron for optimal growth of plants is 100 ppm (0.01%) (Epstein, 1972; Stout, 1961). The maximum amount of Fe (5.9%) was observed in *C. bonariansis* followed by *X. strumarium* (2.7%), *B. biternata* (1.57%) and *E. adenophorum* (0.85%). Which so higher than early reported in *Portulaca oleracea* leaves 0.08 % (dry wt.) iron (Karadge, 1981), in the leaves of *Cassia* species, 0.376 % (dry wt.) iron (Patil, 2009). From the results it can be concluded that all these weeds developed their iron uptake potential. Therefore these species has medicinal potential against iron deficiency problems like Sickle cell anemia.

Copper

Copper as a cupric ion is an essential trace element for algae and higher plants (Walker, 1953). The critical deficiency level of copper in vegetative parts is generally in the range of 0.3 to 0.5 mg/100g (0.0003-0.0005%) dry wt. depending on the plant species, plant organ, developmental stage and nitrogen supply, this range can be larger (Robson and Reuter, 1981). It is a constituent of a protein, plastocyanin, involved in electron transport in chloroplasts, and copper is part of several enzymes, called oxidases (Hochmuth *et al*., 2004). The large amount of Cu (31.9 ppm) was observed in *C. bonariansis* followed by *B. biternata* (20.19 ppm) *X. strumarium* (13.15 ppm) and *E. adenophorum* (11.35 ppm). The higher levels of copper uptake by these weed species indicate that these weed are helpful in bioabsorption of heavy metals or for phytoremediation.

Manganese

Variability can occur in the Mn concentration of seeds, influencing plant growth and development, crop yield and seed quality (Karadge, 1981). According to the report of the food and fertilizer technology center (Report of the Food And Fertilizer Technology Center, 2001) **t**he critical concentration of manganese in the fruit is 10-20 mg/kg dry weight. It plays a pivotal role in the normal growth, skeleton formation and normal reproductive function. The major sources of manganese in soil are fertilizers, sewage

Table.1 Mineral accumulation status in leaves of different exotic weeds (Dry wt.)

Parameters	***Bidens biternata* Laor.**	***Conyza bonariansis* L.**	***Eupatorium adenophorum* Spreng.**	***Xanthium strumarium* L**
Nitrogen %	1.93	1.34	1	0.95
Nitrate N %	0.051	0.048	0.055	0.049
Phosphorus %	1.12	2.5	1.01	1.17
Potassium %	0.75	0.75	1.15	0.7
Calcium %	1.15	1.3	1.55	0.95
Magnesium %	0.54	0.19	0.43	0.31
Sulphur %	0.12	0.11	0.15	0.13
Sodium %	0.4	0.35	0.16	0.3
Zinc ppm	38.96	110.63	38.69	50.94
Ferrous ppm	78.56	298.16	42.96	134.58
Copper ppm	20.19	31.9	11.35	13.15
Manganese ppm	157.39	176.48	695.86	191.78
Molybdenum ppm	0.54	0.34	0.18	0.37
Boron ppm	71.03	33.41	42.87	52.03

sludge and ferrous smelters (Rathanavel and Arasu, 2013). Dietary recommendations established by the Food and Nutrition Board of the Institute of Medicine (IOM) (2004) suggested that 1.8 to 2.3 mg/day intake of Mn is required daily. The higher concentration of Mg (695.86 ppm) was observed in *E. adenophorum*, the moderate concentration was observed in *X. strumarium* (191.78 ppm) and the lower concentration was observed in *C. bonariansis* (176.48 ppm) and *B. biternata* (157.39 ppm). Higher level of manganese in all these exotic species indicates the resistance of plants to various diseases.

Molybdenum

In plants, it plays a role in nitrogen fixation and nitrate assimilation through nitrate reductase which is a key enzyme in the metabolic process in leguminous plants (Soetan *et al*., 2010). Molybdenum is trace element which can exist in several oxidative states. The requirement of molybdenum for plant growth was first demonstrated by Arnon and Stout (1939) using hydrophonically grown tomato. The maximum amount of Mo (0.54 ppm) was observed in *B. biternata* followed by *X. strumarium* (0.37 ppm), *C. bonariansis*

(0.34 ppm) and *E. adenophorum* (0.18 ppm). Improvement in plant molybdenum levels results in a decrease of disease (Bhargava and Khare, 1988). Therefore these exotic weeds are resistant to any disease.

Boron

Boron is also believed to be important mineral element for all vascular plants (Lewis 1980; Lee and Aronoff, 1967). In plants, boron is thought to regulate the metabolic pathways leading to phenol synthesis and is also thought to be involved in the pathway leading to the synthesis of lignin. Lewis proposed that boron's primary role in plants is in the biosynthesis of lignin and the differentiation of xylem tissue. Compounds like leucoanthocyanins, flavonols, flavonones and flavonol-3-glucosides, have been reported to accumulate in borondeficient plant tissue (Rajaratnam and Lowry, 1974; Shkolnik and Abysheva 1975). Although Boron requirements vary among crops, the optimum boron content of the leaves for most crops is 20-100 ppm (Plank, 1999). The large amount of B (52.03 ppm) was observed in *X. strumarium* followed by *B. biternata* (51.73 ppm), *E. adenophorum* (42.87 ppm) and *C. bonariansis* (33.41 ppm). Which is in proper range of optimum requirement that earlier mentioned.

It can be concluded from result that all studied species viz. *Bidens biternata*, *Conyza bonariansis*, *Eupatorium adenophorum* and *Xanthium strumarium* having powerful ferrous, zinc, manganase and molybdenum uptake potential. It indicates that these species may be useful as powerfull tool for phytoremediation. And also these species have potential to tolerate any kind of environmental stress. Therefore they become cosmopolitan and level of iron in these species indicates their high medicinal potential properties against iron deficiency diseases.

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