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A COMPREHENSIVE STUDY REGARDING YIELD AND MINERAL STATUS OF BOTTLE GOURD IN THE SOUTH-CENTRAL COASTAL SALINE REGION OF BANGLADESH

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ABSTRACT

A study was conducted during July 2020 to June 2021 regarding yield and mineral status of bottle gourd under salinity condition in the south-central coastal region of Bangladesh. The study locations were PSTU farm, Dumki; south Muradia, Dumki; Nauvanga, Kalapara; Pakhimara, Kalapara of Patuakhali district and Sawdagarpara, Taltoli of Barguna district having EC level 0.87, 0.97, 4.4, 4.8 and 6.4 dSm^{-1}, respectively. The yield of bottle gourd was increased with the increasing of soil EC level. Bottle gourd was analyzed for determining of minerals such as P, K, Ca, Mg, S, Na, Zn, Fe, Cu and Mn. The findings of the study revealed that P, Ca, S, Zn, Fe, Cu and Mn was in decreasing trend with soil EC level whereas, K, Mg as well as Na was in increasing trend with soil EC level. Results indicated that, the bottle gourd was moderately salt tolerant (soil EC value up to 6.4 dSm^{-1}) and it can be recommended to grow commercially in the study areas.
Key words: Bottle gourd, yield, minerals, salinity, coastal area.

Introduction

Vegetables provide a variety of health benefits being generally low in fat content and calories but rich in vitamins, protein, and fiber. They are also an important source of mineral nutrients such as phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), copper (Cu), manganese (Mn), selenium (Se), and zinc (Zn) (Demir and Mavi, 2008). But, excessive amounts of soluble salts in soil in many regions of the world, particularly in arid and semi-arid areas, limit production of most crops including vegetables (FAO, 2002). It is predicted that by 2050, nearly half of the world's cultivated land will be salinized, posing a great threat to sustainable agricultural development and crop safety production (Butcher *et al.*, 2016). Salt stress is one of the most brutal environmental factors limiting the productivity of vegetable crops because most of the vegetable crops are glycophyte in nature. Salt tolerance is important in vegetables because of their cash value. Salt stress affects plant metabolism, which results in decreased growth and yields. Excess salt in the soil solution adversely affects plant growth either through osmotic inhibition of water uptake by roots or specific ion effects. Specific ion effects may cause direct toxicity, while the insolubility and competitive absorption of ions may affect the nutritional imbalance of plants (Greenway and Munns 1980; Yoon *et al*., 2004; Yang *et al*., 2009). Additionally, salinity has been shown to increase the uptake of sodium (Na^+) or decrease the uptake of potassium (K^+) and calcium (Ca^{2+}) (Neel *et al*., 2002).To overcome salinity stress, engineering salt-tolerant crop plants has been a long-held and intensively sought-after objective. Several transgenic plants that over express the AVP1 gene have been shown to be more tolerant to salt- and/or drought stress than control plants (Gaxiola *et al*., 2001, Pasapula *et al*., 2011, Park *et al*., 2012, Jeong *et al*., 2013).

Materials and Methods

Vegetable and soils were collected during July 2020 to June 2021 from three areas of Barguna and Patuakhali district. Edible portions of bottle gourd (*Lagenaria siceraria*) and soil from each area were collected. The samples were brought to the laboratory, processed and preserved accordingly. The areas were Patuakhali Science and Technology University (PSTU) farm, south Muradia of Patuakhali, Nauvanga, Pakhimara and Sawdagarpara of Barguna. The soil pH was determined in the Laboratory of Agricultural Chemistry, PSTU by the glass electrode pH meter followed by the methodology of Jackson (1973). The electrical conductivity (EC) of collected soil samples was determined electrometrically (1:5, soil: water ratio) by a conductivity as stated by Ghosh *et al*. (1983). Chemical analyses of the vegetable sample were done for different mineral constituents: Exactly 1 g of finely ground vegetable was taken into a 150 mL conical flask and 12-15 mL di-acid mixture (HNO_3:$HClO_4$=2:1) was added. The flask was placed on the electric hot plate for heating at around 180 to 200 degrees Celsius until the white fumes were evolved from the flask (Jackson, 1962). It was cooled at room temperature, washed with distilled water repeatedly and filtered into 100 mL volumetric flask through Whatman No. 42 filter paper and the volume was made up to the mark with distilled water. The plant extracts were preserved separately in plastic bottles for analyses of different nutrient elements. The samples were analyzed for P, K, Ca and Mg (Page *et al*., 1982; APHA, 2005), S (Tandon, 1995) following the standard methods generally practiced in the laboratory. The statistical analysis of data obtained from chemical analyses of vegetables was performed following the statistical package for agricultural research as described by Gomez and Gomez (1984).

Results and Discussion

Soil pH and EC level: Soil pH of the study area was 7.1, 7.2, 7.7, 5.5 and 6.3 in PSTU farm, south Muradia, Nauvanga, Kalapara, Pakhimara and Sawdagarpara, respectively. Soil pH is negatively related with soil electrical conductivity in the form of power function and not in linear relationship because there are several other factors such as soil mineral, porosity, soil texture, soil moisture and soil temperature which also affect soil electrical conductivity in the soil (USDA, 2011). The EC level of soil in PSTU farm, south Muradia, Nauvanga, Kalapara, Pakhimara and Sawdagarpara was 0.84, 0.97, 4.4, 4.8 and 6.4 dSm^{-1}, respectively. The raising of EC level happened because of salinity. The closer we get to the coastal area, the higher the soil salinity (Fig. 1). This result strongly agrees with that of Azam *et al.* (2018), Polara *et al.* (2006) and Kumar *et al.* (2018). The high pH in Sonakata soils might be due to presence of sodium carbonate and bi-carbonates, which precipitated as calcium and magnesium carbonates during evaporation, Bhaskar and Nagaraju (1998).

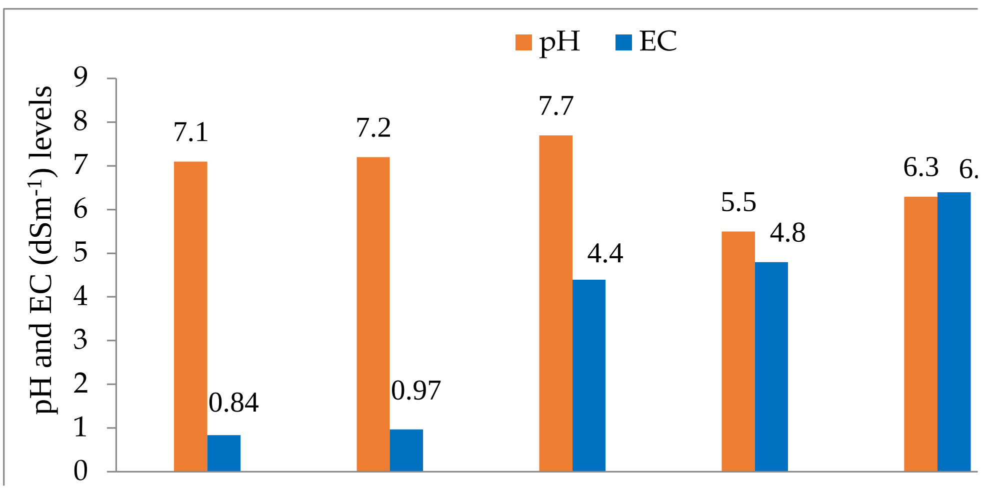

Fig. 1. Soil pH and EC level at different study areas

Yield of bottle gourd: The yield of bottle gourd in PSTU farm, south Muradia, Nauvanga, Pakhimara and Sawdagarpara was 16.97, 18, 30.5, 32.6 and 40.2 tha^{-1}, respectively. The yield was getting higher from PSTU farm to Sawdagarpara because of high organic matter, nitrogen, phosphorus, potassium, sulphur, zinc and boron content of soil (Fig. 2).

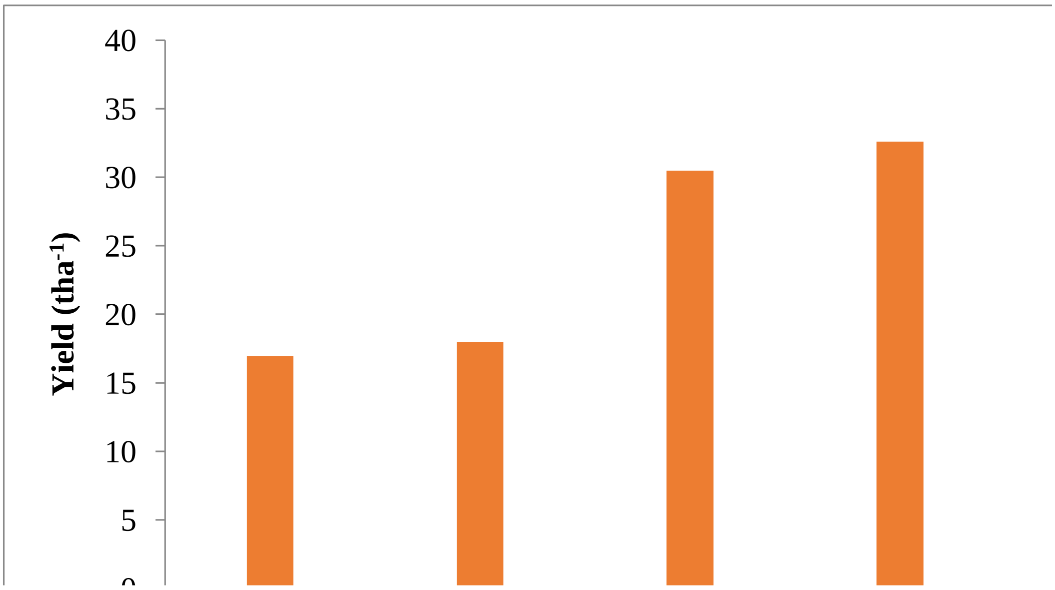

Fig. 2. Yield of bottle gourd at different study areas

Phosphorus and Potassium accumulation in bottle gourd: Phosphorus accumulation in bottle gourd in PSTU farm Dumki, Patuakhali; south Muradia, Dumki, Patuakhali; Nauvanga, Kalapara, Patuakhali; Pakhimara, Kalapara, Patuakhali and Sawdagarpara, Taltoli, Barguna was 4651.8, 5621.2, 6002.8, 6526 and 4189.6 mgkg^{-1}. On the other hand, potassium content recorded as and 23244, 15288, 28548, 29640 and 20124 mgkg^{-1}, respectively. Phosphorus and Potassium accumulation were highest in Pakhimara at EC level 0.84 dSm^{-1} (Fig. 3).

Calcium and Magnesium accumulation in bottle gourd: Calcium accumulation in bottle gourd in PSTU farm Dumki, Patuakhali; south Muradia, Dumki, Patuakhali; Nauvanga, Kalapara, Patuakhali; Pakhimara, Kalapara, Patuakhali and Sawdagarpara, Taltoli, Barguna was 2000, 1600, 2640, 1440, and 1840 mgkg^{-1}; whereas Mg determined as 1920, 1776, 4272, 3696 and 2592 mgkg^{-1}, respectively. Calcium and Magnesium accumulation were highest in Nauvanga at EC level 4.4dSm^{-1} (Fig. 4).

Sulphur and Sodium accumulation in bottle gourd: Sulphur in bottle gourd in PSTU farm Dumki, Patuakhali; south Muradia, Dumki, Patuakhali; Nauvanga, Kalapara, Patuakhali; Pakhimara, Kalapara, Patuakhali and Sawdagarpara, Taltoli, Barguna was 1112, 1484, 1856, 3660 and 1404 mgkg^{-1}. On the other hand Na observed as 11040, 1932, 9660, 8280 and 5888 mgkg^{-1}, respectively. Sulphur accumulation was highest in Pakhimara at EC level 4.8dSm^{-1} and Sodium accumulation was highest in Nauvanga at EC level 4.4dSm^{-1} (Fig. 5).

Zinc and Iron accumulation in bottle gourd: Zinc in bottle gourd in PSTU farm Dumki, Patuakhali; south Muradia, Dumki, Patuakhali; Nauvanga, Kalapara, Patuakhali; Pakhimara, Kalapara, Patuakhali and Sawdagarpara, Taltoli, Barguna was 23.2, 29.6, 54, 64.8 and 30 mgkg^{-1}; whereas Fe accumulation as and 91.2, 72, 119.6, 137.6, 56 mgkg^{-1}, respectively. Zinc and iron accumulations were highest in Pakhimara at EC level 4.8dSm^{-1} (Fig. 6).

Copper and Manganese accumulation in bottle gourd: Copper in bottle gourd in PSTU farm Dumki, Patuakhali; south Muradia, Dumki, Patuakhali; Nauvanga, Kalapara, Patuakhali; Pakhimara, Kalapara, Patuakhali and Sawdagarpara, Taltoli, Barguna was 8.4, 12, 20.4, 19.6 and 7.6 mgkg^{-1}. On the other hand, Mn recorded as 12.4, 19.6, 41.6, 50.5 and 54.4 mgkg^{-1}, respectively. Copper accumulation was highest in Nauvanga at EC level 4.4dSm^{-1} and manganese accumulation was highest in Sawdagarpara at EC level 6.4 dSm^{-1} (Fig. 7).

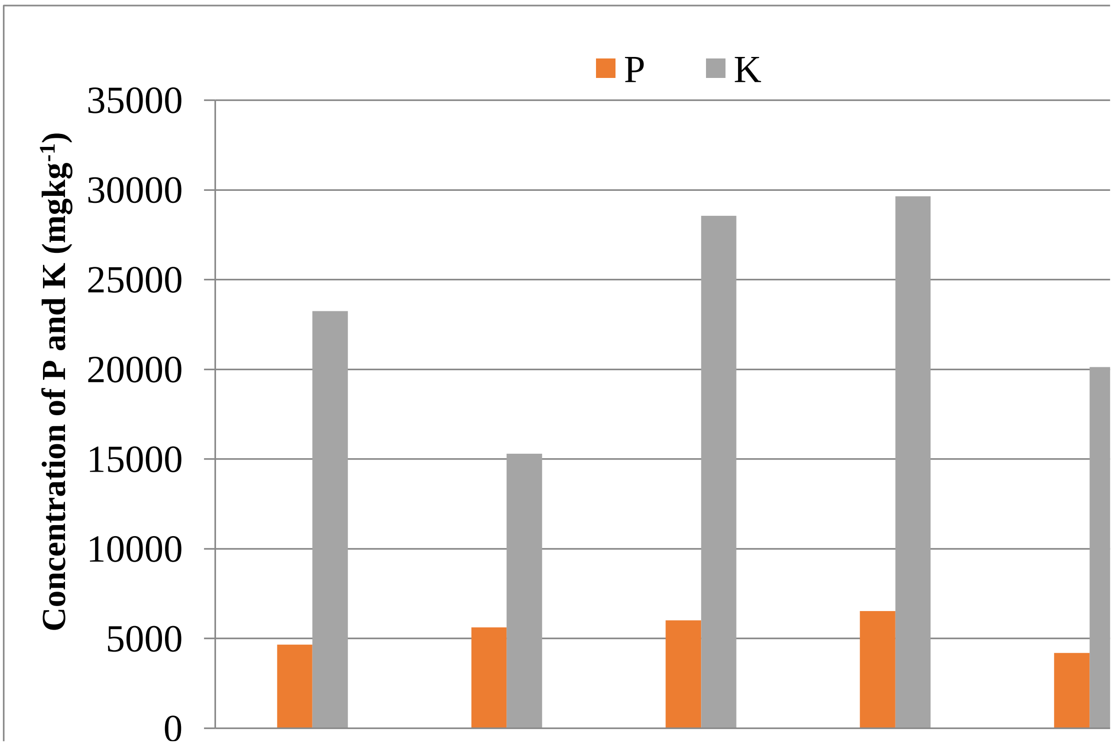

Fig. 3. Accumulation of P and K in bottle gourd at different study areas

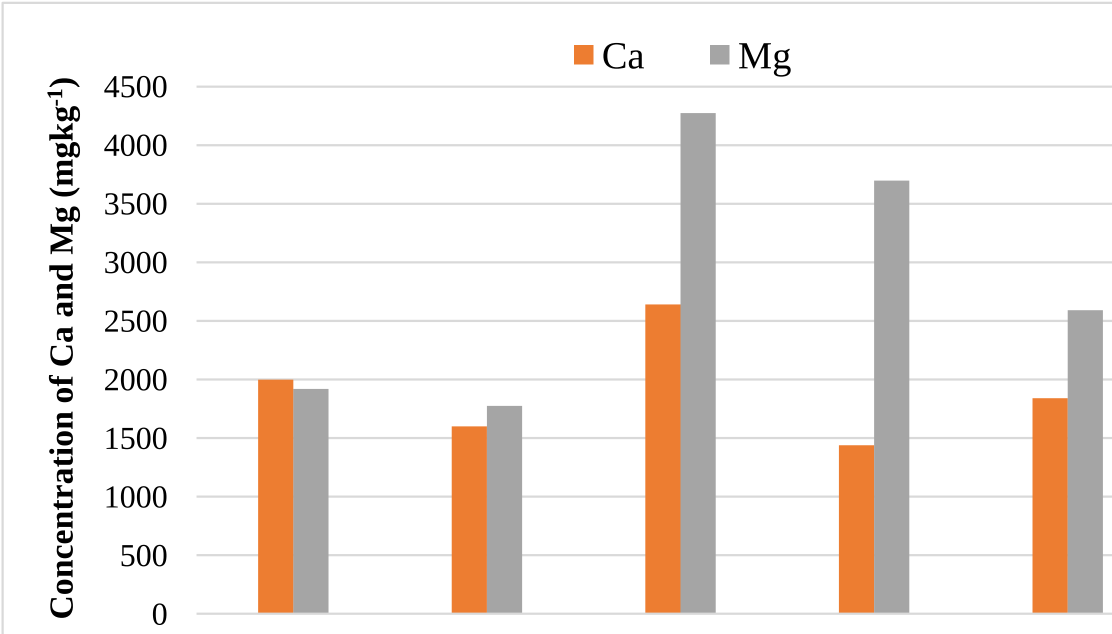

Fig. 4. Accumulation of Ca and Mn in bottle gourd at different study areas

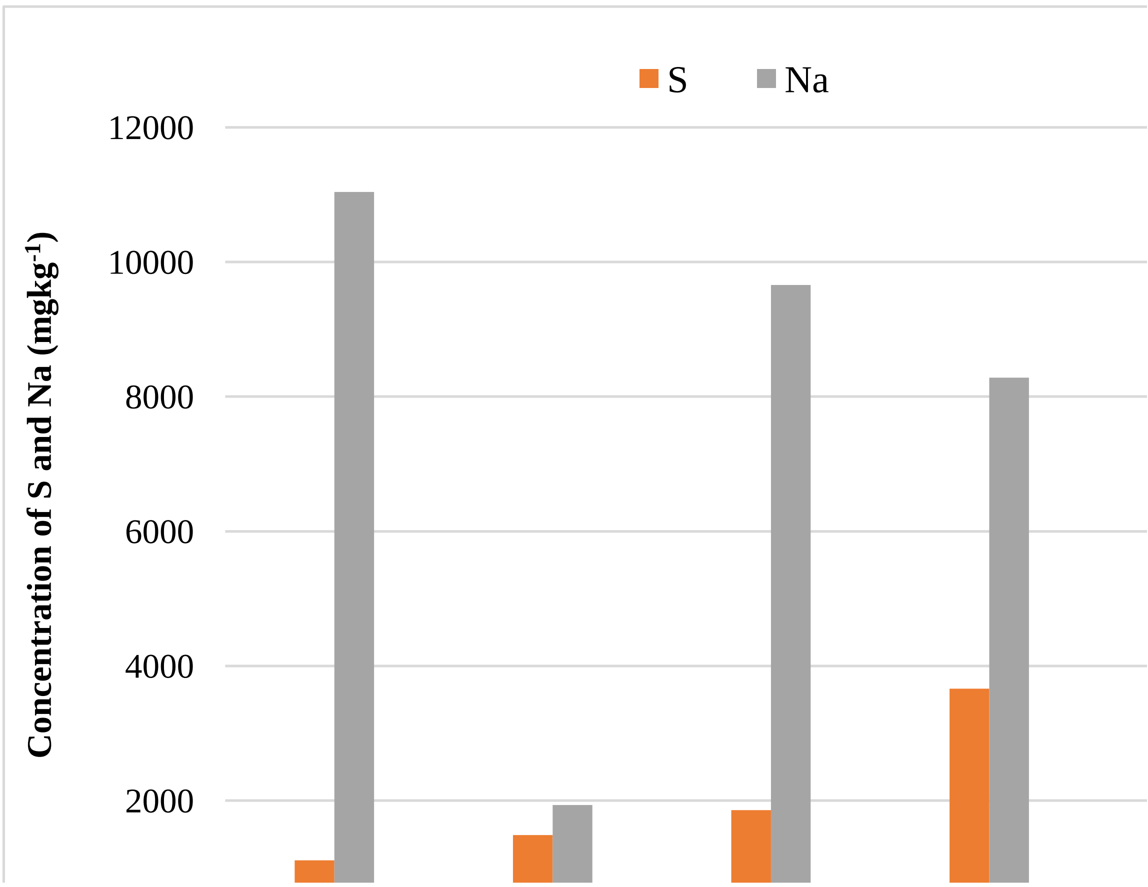

Fig. 5. Accumulation of S and Na in bottle gourd at different study areas

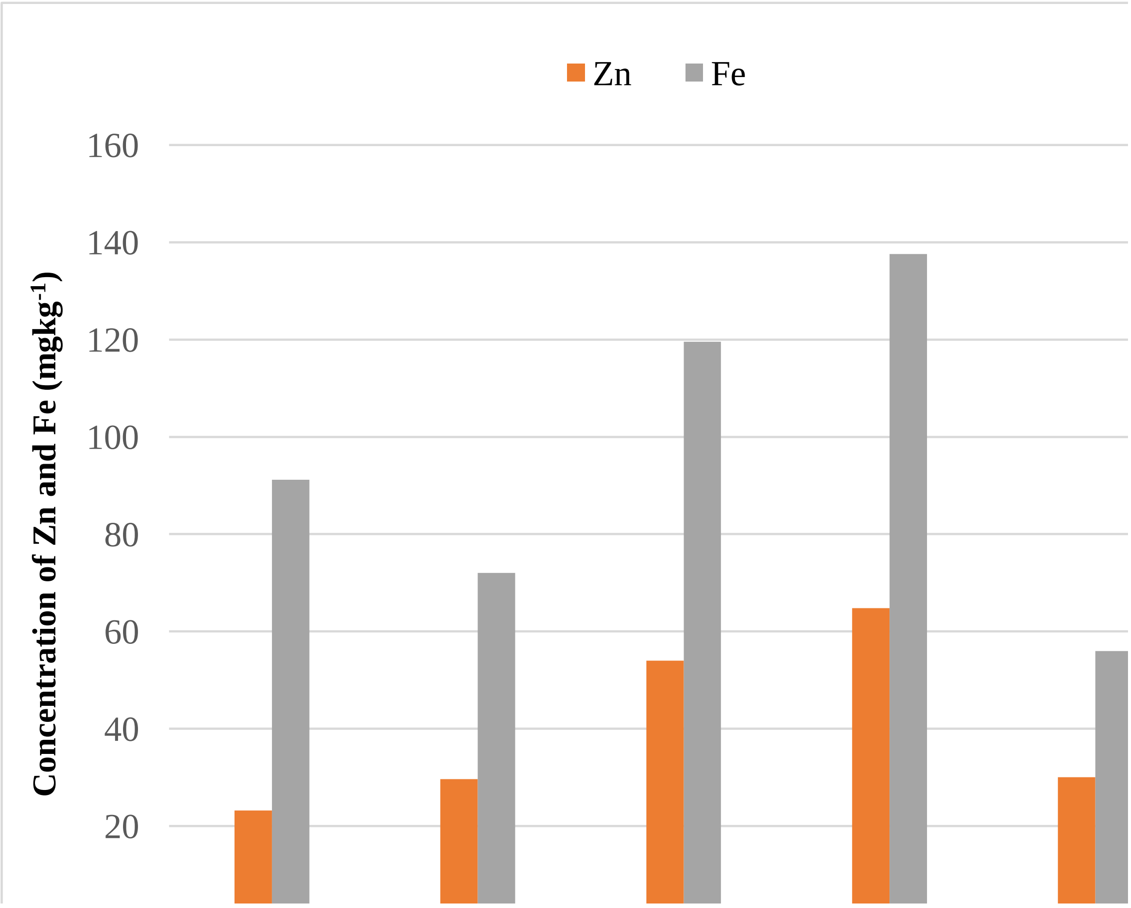

Fig. 6. Accumulation of Zn and Fe in bottle gourd at different study areas

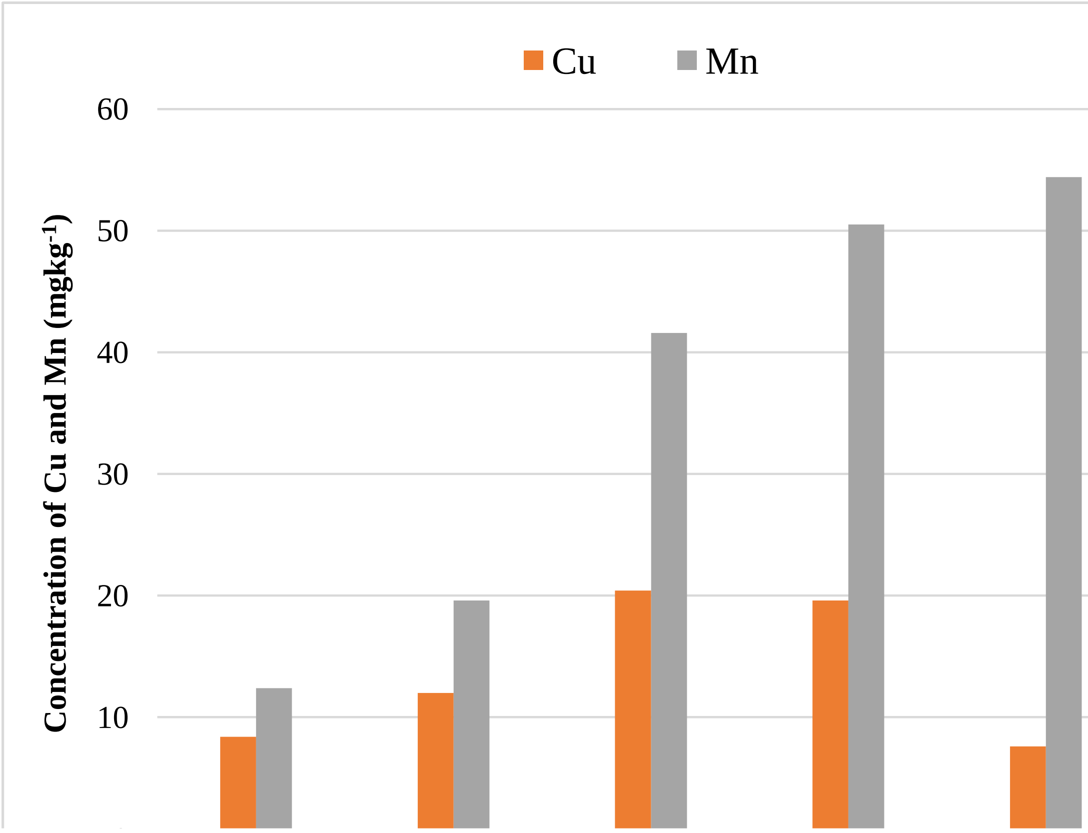

Fig. 7. Accumulation of Cu and Mn in bottle gourd at different study areas

Conclusion

The yield of bottle gourd increased with the increasing of soil EC (up to 6.4 dSm^{-1}). Phosphorus, Ca, S, Zn, Fe, Cu and Mn was in decreasing trend with soil EC level whereas, K, Mg and Na was in increasing trend with soil EC level. Higher accumulation of minerals in bottle gourd was found at higher EC level might be due to its salt tolerance capability. Therefore, bottle gourd is to recommend as moderately saline tolerant vegetable and may be cultivated in the southern central coastal region for nutritional security.

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