Vol 4 Issue 3 Dec 2014

ISSN No : 2249-894X

Monthly Multidisciplinary
Research Journal

Review Of Research Journal

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RNI MAHMUL/2011/38595 **ISSN No.2249-894X**

Review Of Research Journal is a multidisciplinary research journal, published monthly in English, Hindi & Marathi Language. All research papers submitted to the journal will be double - blind peer reviewed referred by members of the editorial Board readers will include investigator in universities, research institutes government and industry with research interest in the general subjects.

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Review Of Research
Vol. 4 | Issue. 3 | Dec. 2014
Impact Factor : 2.1002 (UIF)
ISSN:-2249-894X
Available online at www.ror.isrj.org

ORIGINAL ARTICLE

QUANTITATIVE ESTIMATION OF INORGANIC CONTENTS IN VARIETIES OF CAPSICUMANNUUM AND CAPSICUMFRUTESCENS. II MAGNESIUM, PHOSPHORUS, IRON AND CHLORIDES.

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Abstract:

Capsicumannuum varieties Black short, Deonur Byadagi, Jwala, Pant C-1, Sankeshwari and C. frutescens variety Lavangi are understudy.

Variety Jwala and Pant C-1 contains highest amount of magnesium and phosphorus in fruits and recorded as high yielding in growth and yield beat of this research. Root contains more iron than stem, leaves and fruits, Varieties of C.annuumJwala and Panct C-1 seem to be iron efficient; Stem accumulates more chlorides than root, leaves and fruit. It appears that in these Capsicum varieties the chlorides are less trans located in leaves and large quantity retained in stem. There is varietal and plant part variation in Magnesium, phosphorus, Iron and Chlorides content in Capsicum varieties under study.

KEYWORDS:

Quantitative estimation , Inorganic contents , Capsicumannuum and Capsicumfrutescens.

INTRODUCTION –

Webster's third New International Dictionary defines physiology as " a branch of biology dealing with the process, activities and phenomena incidental to and characteristics of life or of living organisms". B.M. Duggar (1911) made this somewhat more specific Plant Physiology-concerns itself with plant responses and plant behavior under all conditions; that is, with relation and processes readily evident of obscure, simple or complex, which have to do with maintenance, growth and reproduction of plants. Thus, physiological understanding provides a major part of the framework within which the breeder develops his generally implicate thought about what are ideal plants.

Besides the nutritive values, good quality foods are requirements of these days. In crops, like chillie fruit quality must be an important consideration in improvement programme. Breeding for improved quality initially requires a definition of the major parameter that contribute to it. Number of workers such as Shukla etal. (1975), Soochet al.(1977), Bajaj etal. (1977, 1978), Lahadiya and Kulkarni (1978), Bajaj and Kaur (1986), Basiouny and Biswas (1982), Khadietal. (1987) studied chemical composition of chillie fruit only. But little work has been done to illuminate the nutritional requirement of theCapsicum plants (Cotter, 1980). Therefore in present investigation an attempt has been made to understand the growth, yield, organic assimilation mineral nutrient uptake and accumulation in varieties of Capsicumannuumviz. Black short, Deonur Byadagi, Jwala, Pant C-1 and Sankeshwari and C.frutescens variety Lavangi. This information is useful for plant physiologists, breeders and food technologists.

Mineral nutrition of plants is one of the most important factor controlling biomass production. The content and concentration of elements in genotypes of the same plant species vary greatly. Genetic specificity in plant mineral nutrition is manifested not only through the element content of certain plant organs but in the morphological and physiological features and in plant dry matter weight.

Mineral nutrition of plant is a subject of tremendous interest and importance. The metabolic activity of the cell is a complex and highly integrated system. For its proper functioning various mineral ions are required in definite concentration at the sites of all the individual reactions. The knowledge of essential elements is of fundamental importance. At least sixteen elements are essential for the growth of plants (Epstein, 1969). In addition to carbon, hydrogen and oxygen all green plants require potassium, calcium, magnesium, nitrogen, phosphorus, sulphur, iron, manganese, zinc, copper, boron and molybdenum. Cobalt is also included in this list (Wilson and Nicholas, 1967). The capacity of plants for selective or discriminative absorption is remarkable.

MATERIALAND METHOD –

In kharip season varieties of Capsicumannuum viz. Black short, Deonur Byadagi, Jwala, Pant C-1 and Sankeshwari and C.frutescens variety Lavangi sown in experimental field to study growth, yield, organic and inorganic constituents analysis. Randomized Block Design was set. Three replications of each variety were made consisting of twenty plants. Plant to plant and row to row distance was kept 50cm and 70 cm respectively.

In order to determine the moisture percentage in different parts of varieties of Capsicum the plant material was weighted accurately in a petridish and transferred to the oven at 80˚ C. The dry weights of the material were taken repeatedly still constant weight is obtained. The loss in weight per 100 g was expressed as moisture percentage.

A known amount of oven dried material of root, stem, leaves and fruit was digested by the wet digestion method of Tothetal. (1948) by using nitric acid and perchloric acid. The aliquot was later used for estimation of potassium, sodium, calcium, magnesium, iron and phosphorus. Potassium and sodium was estimated by using flame photometer (Richards, 1954) Calcium and magnesium was estimated by using EDTA titration method (Barrows and Simpson, 1962). Iron was determined colorimetrically by the method of Elvehjen (1930). Phosphorus was also determined colorimetrically by using 'molydate vanadate reagent', method of Sekineetal. (1965). Chlorides were estimated from oven dried material by the method of Vohard (1956).

RESULTANDDISCUSION –

Inorganic Content :

Table -II
Inorganic constituents in different parts of Capsicumannuum and C. frutescens varieties

Species/ Variety	Plant organ	Mg	Po_4	Fe	Cl
Capsicum annuum Black short	Root	42.02	5.55	3.460	11.57
	Stem	42.02	6.97	0.447	22.61
	Leaves	94.16	13.24	0.626	15.12
	Fruit	23.02	19.66	0.337	10.10
Capsicum annuum Deonur Byadagi	Root	19.98	8.13	2.700	7.83
	Stem	40.04	7.26	0.268	27.09
	Leaves	64.06	15.69	0.358	13.52
	Fruit	24.01	20.66	0.158	9.77
Capsicum annuum Jwala	Root	28.37	7.55	3.079	12.32
	Stem	52.05	7.55	0.429	25.77
	Leaves	118.08	17.53	0.647	15.23
	Fruit	31.99	22.11	0.393	9.77
Capsicum annuum Pant C-1	Root	36.01	7.55	3.590	10.42
	Stem	52.05	8.42	0.447	19.80
	Leaves	106.08	17.24	0.626	13.63
	Fruit	31.99	21.66	0.358	9.15

Capsicum annuum Sankesh wari	Root	13.98	6.13	2.070	12.01
	Stem	35.36	5.71	0.316	22.84
	Leaves	82.07	14.52	0.447	17.46
	Fruit	30.01	20.30	0.393	13.60
Capsicum annuum Lavangi	Root	34.04	6.00	3.490	10.49
	Stem	44.04	5.13	0.395	20.05
	Leaves	96.13	17.24	0.447	12.67
	Fruit	28.87	17.82	0.358	9.57

All values are expressed in meq per 100 g dry tissue.

aMagnesium : Magensium plays several important roles in plant metabolism. It is found both in the combined form as well as in the form of inorganic salts in the cell. Overstreet and Jacobsen (1952) have reported that calcium and magnesium are slowly absorbed ions as compared to the monovalent cations. The average value of magnesium for optimum growth in land plants is 0.2% (Epstein, 1965). Nonsaline succulents like Bryophyllum pinnatum contains 2.36% of magnesium (Karmarkar, 1965).

Magnesium is the part of chlorophyll ‘a’ and chlorophyll ‘b’ molecules and thus present in all autotrophic plants. It can be said that magnesium is essential in photosynthesis. Arnon etal. (1955) have shown that CO2 fixation in dark and night cannot take place if magnesium is not present in broken chloroplast preparation. Weissbachetal (1956) have reported that RuDP carboxylase requires mangesium as a co-factor. Hill and Whinttinghum (1955) have observed a decrease in the rate of photosynthesis in Chlorella due to deficiency of potassium, magnesium or manganese.

Magnesium plays prominent role in many enzymatic reactions. It is required in number of physiological reactions where ATP is involved. Mazelis and Stumf (1955) have found that magnesium is involved along with adenine nucleotide and a Krebs’s cycle intermediate, in the esterification of phosphorus into ATP.

Guha and Mitchell (1966) have shown correlation between total magnesium and the organic constituents. Zillingetal. (1959) have stated that magnesium plays an important role in protein synthesis. Bear et al. (1951) have shown that young cells, rapidly growing tissues and mitotic cells require magnesium. Thus it can be said that magnesium plays diversified role in plant metabolism.

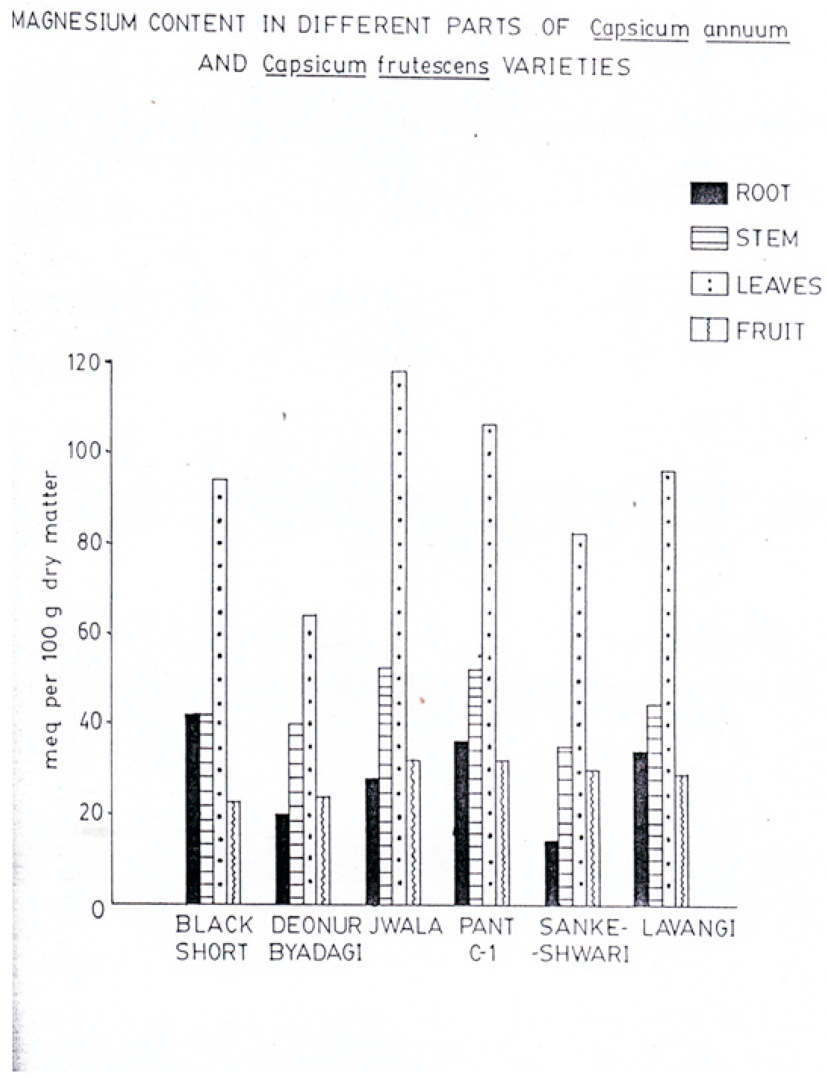
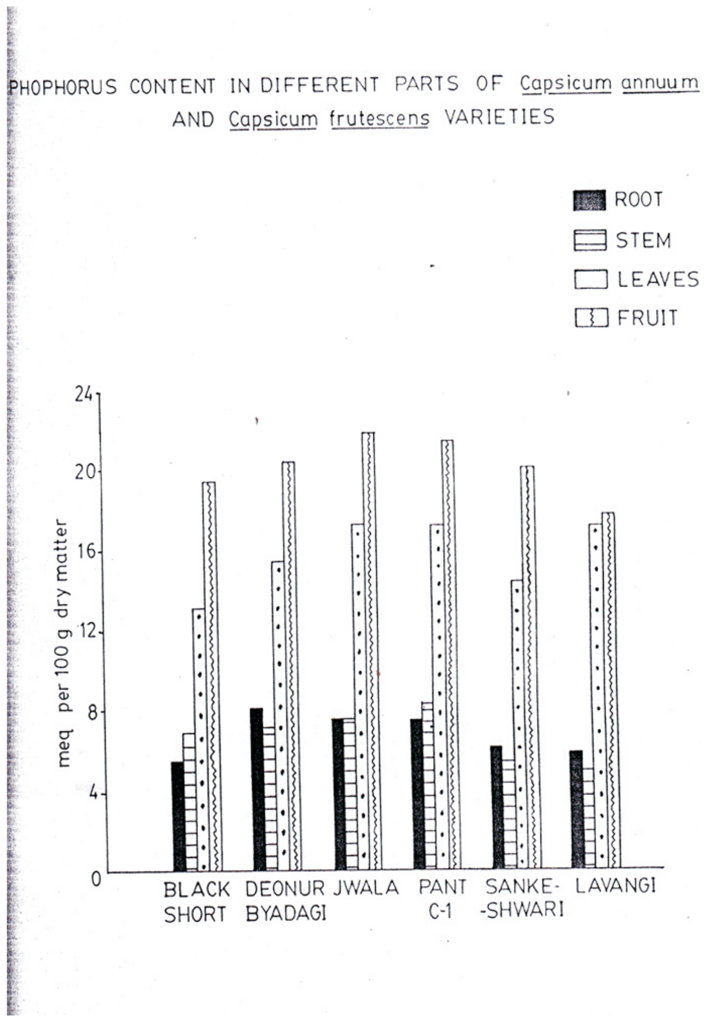


Table I summarizes magnesium content in different parts of Capsicum annuum varieties Black short, Deonur Byadagi, Jwala, Pant C-1 and Sankeshwari and C. frutescens variety Lavangi. The range of magnesium content in root, stem, leaves and fruit varies from 13.98 to 4.02 meq, 35.36 to 52.05 meq, 64.06 to 118.08 meq and 23.02 to 31.99 meq per 100 g dry tissue respectively. It clearly indicates that the leaves of different varieties under study contains high magnesium than other plant parts. This reveals that root absorbs magnesium and with less accumulation trans located to stem, leaves and fruits.

It is revealed that there is varietal variation in magnesium uptake and accumulation in Capsicum species under study. Syare (1952) recorded varietal variation in calcium and magnesium accumulation in leaf samples of 31 maize inbreeds grown in gravel culture. Snaydon (1962) found differential responses of Trifolium genotypes to calcium and magnesium. Bhandari (1988) reported magnesium content in leaves, stem and root of Capsicum annuum variety N.P. -46A and Pant C-1 with value of 38.18, 10.65, 11.09 and 47.68, 12.05 and 9.47 meq per 100 g dry tissue.

Bajaj and Kaur (1986) studied 17 genotypes of Capsicumannuum and stated that high yielding varieties has the highest content of potassium, magnesium and phosphorus in fruit. In present study, variety Jwala and Pant C-1 contains highest amount of magnesium in fruits and recorded as high yielding in 'Growth and Yield' beat of this chapter.

b.Phosphorus: - The function of phosphorus as a constituent of macromolecular structures is most prominent in nucleic acids, which, as units of DNA molecule, are the carriers of genetic information and as units of RNA are the structures responsible for the translocation of the genetic information. In both DNA and RNA, phosphate forms a bridge between rib nucleotide units to form macromolecules. Although present in cells only in low concentrations, phosphate stress



and energy rich phosphates represent the metabolic machinery of the cells.

The accumulation of phosphorus in different parts of Capsicumannuum varieties Black short, Deonur Byadagi, Jwala, Pant C-1 and Sankeshwari and C.frutescens variety Lavangi shown in Table I. Table shows that among the varieties, fruits are rich in phosphorus content, followed by leaves and then after may be root or stem. Phosphorus content in varieties under study varies from variety Deonur Byadagi (8.1 meq) to Black short (5.55 meq) in root, variety Pant C-1 (8.42 meq) abd Jwala (7.55 meq) to Lavangi (5.13 meq) in stem, variety Jwala (17.53 meq), Pant C-1 and Lavangi (17.24 meq each) to variety Black short (13.24 meq) in leaves and variety Jwala (22.71 meq), Pant C-1 (21.66 meq) to Lavangi (17.82 meq per 100 g dry matter) in fruits. There are several reports on plant genotype differences in phosphorus uptake, accumulation and use (Bieleski, 1973; Chapin, 1980; Clark and Brown, 1980; Epstein and Jefferies, 1964).

Differences among maize genotypes with high and low phosphorus accumulation properties were attributed to root size, the ability to compete effectively for phosphorus, the ability to tolerate detrimental effects of competing or harmful elements like Al and to root phosphatase activities (Clark and Brown, 1974). Differences among maize genotypes for phosphorus uptake were 2-3 fold (Snhenk and Barber, 1979). Early maturing maize genotype appeared to absorb and accumulate more phosphorus than late maturing genotypes (Bruetsch, 1976).

Present investigation reveals that there is varietal variation in phosphorus uptake and accumulation. Bhandari (1988) also found varietal variation in phosphorus uptake and accumulation. Basiouny and Biswas (1982) found that during fruit ripening phosphorus content increases in Capsicum.

Bhigrut, Bajaj and Kaur (1986) studied 17 genotypes of Capsicum annuum and stated that there is varietal variation in phosphorus content of fruit of different genotypes. They also added that high yielding variety had the highest contents of potassium, magnesium and phosphorus in fruits. In present study variety Jwala and Pant C-1 are high yielding and also containing high phosphorus in fruits.

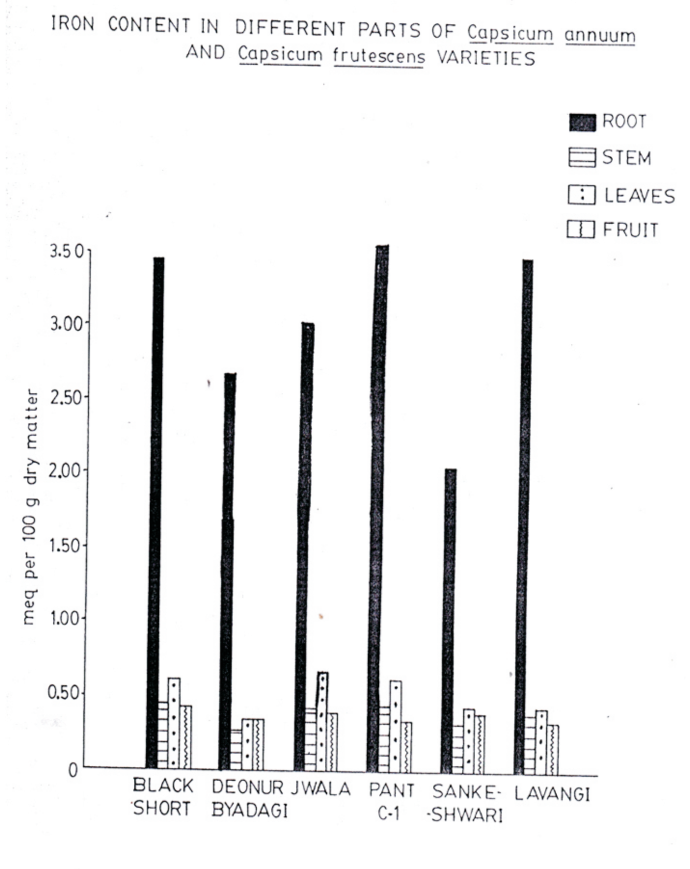
c.Iron: - Iron is an important micronutrient element essential for plant growth. As compared to other micronutrients it is the most abundant in soils and also in plants. Generally iron is absorbed in ferric form but it is active in ferrous state. After absorption it is immediately converted into ferrous form.

Epstein (1965) has observed that the values for land plants are 2 M mole or 0.011 g per 100 g dry tissue. Iron is different from almost all other nutrient elements in that its optimal concentration range in plants is much lower than its frequent concentration range in the soils. Banin and Navrot (1972) have suggested this observation of uptake of iron by plant.

Bogorod (1966) found that iron is essential for chlorophyll synthesis. Nason and McElory (1963) have reported that respiratory energy required for salt uptake and accumulation in plants involves the iron containing enzymes.

Iron is a component of several nonheme enzymes, such as some flavoproteins and the extremely important electron transfer agent ferredoxin which is involved in photosynthesis as the primary electron acceptor, as well as in nitrogen fixation.

Iron content in different parts of Capsicum annuum varieties Black short, Deonur Byadagi, Jwala, Pant C-1 and Sankeshwari and C- frutescens variety Lavangi is presented in Table I. From the table it is clear that root accumulates more iron than other plant organs. Range of iron content is 2.07 to 3.79 meq per 100 g dry tissue. Variety Jwala and Sankshwari and the two extremes. Stem contains iron in range of 0.268 to 0.447 meq per 100 g dry tissue. Stem of variety Black short and Pant C-1 has shown maximum accumulation while variety Deonur Byadagi accumulated lowest



amount of iron in stem. The leaves contain maximum iron in variety Jwala (0.647 meq) and minimum in variety Deonur Byadagi (0.358 meq per 100 g dry tissue). Iron content in fruit varies from 0.337 to 0.393 meq per 100 g dry tissue.

Plant genotype differences to iron have been recognized in many plant species for many years (Brown, 1956, 1961, 1977, 1978; Brown et al. 1972, Clark and Brown, 1980; Clark et al. 1981; Wallace and Lunt, 1960). It is evident from the present investigation that there are varietal differences in uptake and accumulation of iron. This result agree with previous findings of Khadi et al. (1987). Brown and Ambler (1974) observed tomato varieties differ in their ability to utilize iron.

The pattern of iron accumulation in chillie plants under study is that root contains more iron than stem, leaves and fruits. Bhandari (1988) also observed similar type of accumulation pattern in Capsicumannuumvarieties Pant C-1 and N.P. 46A. However, the values of iron content presented in present investigation are lower than that of recorded by Bhandari (1988).

It is evident from the table that varieties of Capsicumannuum Jwala and Pant C-1 seems to be "Iron efficient". It has been shown by Bennett et al. (1982) that 'Iron efficient' plant genotypes usually exhibit following principles –

1.Roots with a greater ability to reduce $Fe3+$ to $Fe2+$ by producing $H+$ or $Fe3+$reductant when needed.
2.The plants show fewer complications from interfering elements like P,Ca, Cu, Zn, Mo, Al and heavy metals and
3.The plants have chelating and storage compounds as exhibit chemical/photochemical processes inside the plants that regulate iron availability and utilization.

Although not yet fully understood, iron efficiency is associated with physiological activities and dynamics of storage and metabolism reaction associated with energy transfer processes, chloroplast development, nitrogen metabolism and iron distribution and storage. Numerous enzymes and redox agent that are vital to plant metabolic processes including photosynthesis, respiration, cellular protection, nitrogen fixation and many other general metabolic functions require iron as an indispensable co-factor.

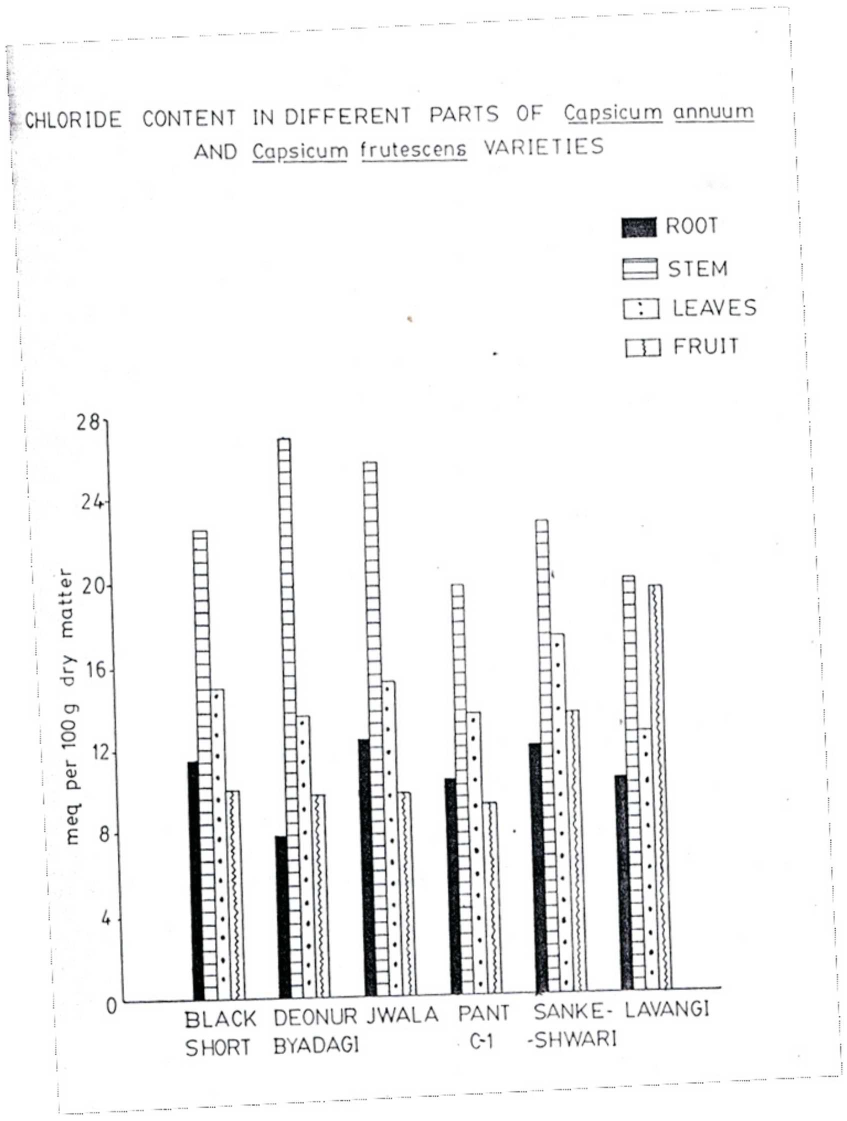
It is also evident from the table that much of the iron is found stored in root parts of the plant. Iron distribution studies show that roots of green plant may contain 5 to 20 times more iron than is found in the foliage (Brown, 1966, 1977; D'Souza and Mistry, 1979, Wadkar, 1989). Iron in plant tissues is not readily metabolized and retranslated to other tissues (Brown and Chaney, 1971).

c.Chlorides – It has been observed that chlorides in low quantities are essential for better growth. However, in larger amounts they are harmful to plants. Though many plants contain appreciable amount of C1 the exact role of chloride in the plant metabolism is not clearly understood. The recent investigation indicates that chloride ions in micro quantities are necessary for certain metabolic activities in the higher plants.

Lipman (1938) has shown that chloride is beneficial iron for plants. Broyer et al (1954) have mentioned that chloride is necessary for growth of higher plants and they have also shown that chloride accumulation is more in older plants. Ashirov and Knosav (1966) reported that chloride is needed for the development of vegetative parts and is undesirable for reproductive organs.

Chloride play an important role in association with enzymes of photosystem II. Warburg and Luttgens (1944) first observed the stimulating effects of chloride iron on the Hill reaction in isolated chloroplasts. Hind etal. (1969) and Izawa etal. (1969) have reported the stimulating effect of chloride iron on Hill reaction.

Table I and shows the chloride content in different parts of Capsicumannuum varieties Black short, Deonur Byadagi, Jwala, Pant C-1 and Sankeshwari and C. frutescens variety Lavangi. It is



clear from the table and figure that stem accumulates high amount of chloride than other plant parts of varieties under study. Range of chloride content in roots is 7.83 to 12.32 meq per 100 g dry tissue. Variety Jwala and Deonur Byadagi are the two extremes. Stem contains 19.80 to 27.09 meq chloride per 100 g dry tissue. Stem of variety Deonur Byadagi and Pant C-1 are the two extremes, while range of chloride content in leaves is 12.67 to 17.26 meq per 100 g dry tissue. Variety Sankeshwari accumulates maximum chlorides in leaves, while variety Lavangi shows minimum. The chloride content in fruit is maximum in variety Sankeshwari (13.60 meq) and minimum in variety Pant C-1 (9.15 meq per 100 g dry tissue).

Bhandari (1988) recorded 33.3, 10.9, 16.15 and 40.28, 9.34 and 18.00 meq chlorides in leaves, stem and root of Capsicumannuum variety N.P. 46 and Pant C-1 respectively. In present study also there is varietal variation in chloride uptake and accumulation. It also reveals that stem accumulates more chlorides that root, leaves and fruit. It appears that in these Capsicum varieties the chlorides are less trans located to leaves and large quantity retained in stem.

From the foregoing discussion on physiological studies in parental varieties of Capsicumannuum and C. frutescens the following conclusion can be drawn –

There is wide difference in growth parameters of Capsicum varieties.

Chillies exclusively cultivated for fruits when this criteria is considered variety Jwala appears to be better in yield followed by Pant C-1, Deonur Byadagi, Sankeshwari, Lavangi and Black short.

There are varietal differences in organic acid metabolism, carbohydrate assimilation, and content of nitrogen, protein, polyphenols, chlorophylls, capsicum, capsaicin and ascorbic acid.

CONCLUSION–

Varieties of Capsicumannuum and C. frutescens showed important differences in dry matter, moisture percentage and varietal variation in uptake, translocation, accumulation and use of the essential mineral elements.

Variety producing greater dry matter of fruit gave the higher yield. Variety Jwala is high yielding and contains high amounts of potassium, magnesium, phosphorus, chloride and less calcium in fruits. Roots absorb calcium; magnesium accumulates some part and remaining calcium, magnesium trans located to shoot where it retained in leaves mostly. The pattern of sodium, iron accumulation is that root contains more sodium and iron than in stem, leaves and fruits. High yielding variety have the highest iron uptake. In these Capsicum varieties the chlorides are less trans located to leaves and large quantity retained in stem.

What emerges from this overall discussion is that plant genotypes of Capsicumannuum and C.frutescens show important differences in their growth pattern, organic metabolism, uptake, translocation, accumulation and use of essential mineral elements. Advantage should be taken of these differences to improve plants for growth under defined or constrained conditions.

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