Review of Literature

Importance of Nutrition:

It was first thought that water was the only plant nutrient which helped in plant growth, but later Aristotle discovered that plants take up their nutrients from the soil like other organisms on the earth. Later it was established that ash elements are also indispensable.

Macro elements essential to plant nutrition which required in relatively large amount by the plant are recognised as N, P, K; Ca, Mg, and S. At present, N, P, and K are termed as primary nutrients while sulphur, calcium, and magnesium are called secondary nutrients which are needed by plants in small quantity. They are termed as micro nutrients. They are iron, manganese, zinc, copper, boron, molybdenum, and chlorine. The term does not mean that they are in any manner less important than primary or secondary nutrients. Plants take these elements from the soil. Lack of these nutrients they are provided through fertilizers. Horticultural crops have tremendous potential for fertilizers use. These are heavy feeders of plant nutrients and a number of crops may absorb 500-1000 Kg of N+P2O5+K2O ha^-1 year or even more under good management conditions. Fertilizers is a proven input for increasing crop productivity, crop quality, and farm income. Such an understanding can only be brought by a multidisciplinary approach to mineral nutrition of crops.

Fertilizer use is therefore, must for production of high yield of good quality. Each nutrient whether macro or micro, performs specific functions in plants which cannot be carved out by any nutrient. Zinc like other trace elements, was known to be present in plants even before evidence was
presented in 1869 to show that it was essential for the normal growth of
aspergillus niger (Raunin 1869). It was found to be related in formation of
chlorophyll and the development of green colour in the leaf. Thus it was consider
indispensable for the growth of all living organisms and its deficiency caused
abnormalities in external growth and accumulation of phenolic substance,
phytosterols oil and calcium oxalate.

Raunin a French scientist first investigated the indispensable role of
micronutrients other than the major ones. Some elements may be present in
soil in abundance yet unavailable because they are either tied up in chemical
compounds that the plant cannot use in absence of biocatalyst like trace
elements. This can be ascertained by soil analysis.

Stiles (1951) reviewed the role of different micro-nutrients in
metabolic activities of plants in which individual and combined action of known
trace-elements along with their antagonistic behaviour were discussed. Out of
them, role of zinc fertilization is spectacular so much that total crop failure is
not common without zinc application. The role of zinc element is being reviewed
in the following paragraphs.

GROWTH

Generally, the micronutrients are applied through foliar spray on the
fruit plants because they require in very low amount. But in combination of
Cu, Zinc and boron through basal dressing is also being in practice in western
U.P. in the orchards of mango, peach, and litchi.

The most prominent role of zinc in plant is involved with auxin metabolism.
The Skoog (1940) previously observed that auxin content was low in the zinc
deficient plant, while Tsui (1948) and Nason (1950) reported that zinc element
synthesis which is the precursor of the auxin. Auxin content present in apical bud is responsible mostly for growth of plants. Doby (1965) observed that zinc is capable of activating to the several enzymatic processes leading to the formation of strach, synthesis of vitamin B and indole acetic acid. Zinc acts as a catalyst in various physiological activities such as oxidation reduction process etc. Embleton and Jones (1959) found in their experiment that zinc does not readily translocated from old to young leaves. Various metallic role of biochemical activity in the enzyme have been studied by Kagi and Vallee (1960).

Mathios (1958) observed that zinc is firmly bound to metalloc enzymes in animal liver and kidney. He also observed that these are also present in several plant tissues in similar metalloc enzyme structure. Srivastava et al. (1977) studied on citrus reticulata found that spraying of Zn, Mn, Mg, Cu, and Mo increased girth and volume and decreased chlorosis in comparision to untreated plants.

Ray Chaudhary (1961) and Prasad et al. (1966) observed in guava that deficiency of zinc caused interveinal leaf chlorosis, reduced size and leatheriness in leaves suppression of growth die back in branches. Foliar spray of zinc sulphate or zinc oxide was effective to correct the above shortcoming (Singh and Mishra, 1977). Zinc content of leaves was also increased by spraying zinc sulphate (Kanwar and Dhingra, 1962) and (Hoffman and Sarmish, 1966). In case of mango, foliar spray of zinc increased the vegetative growth (Oppen Heimer and Gazit, 1961). Chattopadhyay and Gogai (1990) also observed that application of zinc increased plant growth, girth spread and number of leaves per plant. Menzel and Simpson (1990)
(1957) in fig and Dutta (1962) in citrus. By increasing the dose of zinc sulphate spraying from 0.2 to 0.8 percent showed a significant increase in the length of terminal shoots, the number and area of leaf per shoot and fresh and dry weight of leaves of Chausa mango (Rajput et al. 1976 b). Rajput and Ram (1979) observed in Dashehari, Langra and Fazli mango that three spraying of zinc at 0.1 and 0.4 percent respectively caused improvement in flowering fruit set, fruit retention and fruit quality while Rathi et al. (1980) studied on Langra mango recorded an increased in fruit length, diameter and weight by treating the plants with zinc at 0.2 to 0.8% at full bloom stage. Fazli showed 8.2 percent panicle emergence when the plants were treated with zinc at 0.1 percent (Anon,1982) Increasing the level of zinc from 0.1 to 0.5% resulted in marked improvement in the production of perfect flower, while higher level of zinc (0.5%) in combination with higher level of boron (0.4%) and Fe (0.4%) tended to produce more male flower. Rajput and Chand (1975) also noted the beneficial effects of zinc spray on Allahabad Safeda. Preflowering spray of zinc sulphate (0.3%) gave best result in increasing fruit size.

Brahmachari, et al. (1997) observed that the number of pistilate flowers, fruit retention, yield per plant, edible and non-edible ratio were highest with the foliar spray of 1.0 percent Zn SO₄. The interveinal chlorosis, reduced size and leatheriness of leaves reduced plant growth, dieback of branches, production of few or no flowers and drying and cracking of fruits attributed to zinc deficiency (Vasudeva 1954). Reported that symptoms of zinc deficiency are mostly found in lighter soils also they suggested two bi-monthly summer sprays of commercial zinc sulphate (0.45 Kg Zn SO₄ + 319 gm lime in 72.1% litre of water) to overcome zinc deficiency. They concluded that zinc sulphate was more effective than zinc oxy sulphate.
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YIELD AND QUALITY

It has been observed that nutritional status of soil is decreasing continually with the deficiency of zinc resulting plants have depressed their growth which caused heavy loss in quantity and quality of the fruits. In case of mango the deficiency of Cu and Zn was covered by foliar sprays of CuSO₄ and ZnO respectively. Bogun (1963) obtained higher berry size, weight, sugar content and grape yield by foliar application of zinc in grapes. Sawacer Singh et al. (1992) reported that the application of Zn SO₄ at 15 kg / ha and borax at 2.7 kg / ha in addition with normal fertilizer significantly increased yield. Similar results had also been found in foliar spray of 0.5% Zn SO₄ + 0.1 percent borax.

Zinc deficiency was found to be the cause of severe malformation in mature mango trees which had become unproductive. To overcome the deficiency, spraying with Zn SO₄ or ZnO was suggested by Martin - Prevel et al. (1975). Nijjer et al. (1976) reported that zinc deficient mango cv. Dashehari had a leaf zinc content of 27.5 ppm compared with 35.2 ppm in leaves of apparently healthy plants. Spraying of Zn SO₄ at 0.2 and of 0.4 percent raised the leaf zinc content to 42.5 and 92.5 ppm respectively.

Kumar et al. (1995) worked on the effect of potassium, zinc and Molybdenum sprays on litchi reported that 1% zinc sulphate increased T.S.S., ascorbic acid and sugar. Previously, Awasthi et al. (1975) proved that Zn SO₄ at 0.5, 1.0 or 1.5 percent foliar spray was effective in increasing fruit & pulp weight and T.S.S. content of fruits and decreasing acidity of the fruit. However, Hoda and Syamal (1975) reported that the effect of zinc and growth regulator on sex and fruit formation in litchi, spray of zinc sulphate at 0.5 or 1.0% did not affect male & female flowers but fruit set was increased by both...
concentration. While reported that combined spraying of zinc & boron at 0.2 to 0.8% significantly increased the T.S.S., sugars and ascorbic acid contents in Langra mango. Arora and Singh (1970 C) reported that foliar spray of 0.4% zinc sulphate increased vitamin C, total sugar and T.S.S. content in guava fruits. Singh and Chhonkar (1983) also concluded the same results in guava, while Mansour and EL-Sied (1981) reported that foliar spray of zinc sulphate at 0.5% or 1.0% increased fruit yield.

Malik et. al. (2000) observed in an experiment that the maximum number of fruits and yield per tree were found in those Killnow trees which sprayed 0-1.5% urea and 0-0.8 percent zinc sulphate respectively. The maximum juice and T.S.S. were found with 1.0% and 0.8% urea and zinc sulphate respectively. However acid content in fruits decreased with increasing concentration of urea and zinc sulphate. Mani et. al. (2001) found that at harvest stage in mango, zinc sulphate with press mud exhibited 46.1% higher yield than the untreated control. Zinc sulphate with pressmud obtained the highest mean suitable yield (38.46% / ha). Likewise Reestama et al. (2001) observed that increased level of zinc in leaves improved fruit size and quality in compare with fruits of control trees.

Sazida - Perveen and Hfeez-ur-Rehman (2000) reported that in sweet orange zinc spray significantly increased zinc level in leaf and fruit yield in compare to tree where zinc was not included in foliar spray. The highest yield of 105.3 kg / tree was obtained from trees sprayed with zinc alone. Based on the value cost ratio and maximum net return on the value cost ratio and maximum net resurch, 0.4 kg Zn/ha in the presence of 0.4 Kg Zn/ha in the presence of 1.56 kg N/ha (urea) and surf 0.4 kg/ha is recommended for a higher production of citrus and for curing the zinc deficiency in Peshawar.
Valley Singh et. al. (1999) observed that ascorbic acid content of the fruit pulp is increased greatly with the higher concentration of zinc in guava, while Lal et. al. (2000) reported that 4 g/tree spray of Zn SO₄ increased yield and Zn content in leaves of guava. Sourour MM (2000) found in citrus that chelated zincie Zn-EDTA increased number and weight of fruits. It was also observed that chelate form of zinc was better than the sulphate form. The increase in T.S.S., total sugar and sugar/acid ratio of fruits and decline in fruit acidity in guava with zinc application were studied by Kundu and Mitra (1999).

Chandel (1995) observed in his experiment on litchi found that highest fruit set, retention, size, weight and yield recovered in irrigated blocks while Chandel et. al. (1995) found that spray of zinc sulphate in litchi reduced fruit cracking (6.69%) and increased the net profit tree by Rs. 117.34 compared with a untreated tree.

Sinha et. al. (1999) observed very good results by applying zinc and GA or 2,4-D on the litchi tree. They concluded that zinc with growth regulator increased yield and fruits quality.

Chen-WS & Ku-ML (1988) selected terminal shoots on tree of litchi, were sprayed with ethephon at 200 ppm liter & 20 days later, Kinetin 200 ppm application gave good effect in reducing shoot length, flower bud formation and earlier of panicle emergence.

Thakur et. al. (1989) found that the best fruit set, fruit retention and fruit size were obtained with GA3 application at 50 ppm. the 2000 ppm CCC treatment produce the heigher number of hermaphrodite flowers/panicle.

Gliush et. al. (1987) reported that the plant treated with NAA 20 ppm gave the best fruit retention and yield over the control Menzel & Simpson.
(1987) reported that deficiencies of N & K, and to a lesser extent of B, Zn & Cu may limit yield by restricting the set and subsequent development of fruit.

Hasan & Chattopadhyay (1990) found that GA3 at 50 ppm, Borax at 0.5% zinc sulphate at 0.5% and AgNO₃ 400 ppm were most effective in increasing fruit set compared with untreated plant while NAA 20 ppm, GA3 25 ppm, borax 0.05% and Zn SO₄ at 0.5% were highly effective in fruit drop.

Hoda et al. (1973) found that with NAA 10 ppm plus ZnSO₄ at 1.0% treated plants or 2,4-D 15 ppm plus ZnSO₄ at 1.0% treated plants significantly increased the fruit retention over control, however 2,4-D at 20 ppm was found injurious.

Pujari & Syamal (1977) showed that fruit dropped percentage was reduced from 75 to 56 by using 2,4,5-T at 25 ppm foliar application. Addition of zinc boron made little difference while spraying with boron at 0.5% reduced fruit drop by 66%.

Sharma & Dhillon (1987) reported that the highest fruit retention, fruit-weight and quantity were obtained with NAA at 10 ppm in Dehradun litchi.

Stern & Gazit (1999) found that application of synthetic auxin 3.5, 6-TPA decreased fruit drop and increased yield by 130 to 170% compared with untreated control tree.

Verma et al. (1981) found that all treatments reduced fruit drop over control while best results obtained with NAA at 10 ppm plus boron and zinc.

Sharma & Dhillon (1986) reported that the fruit parts examined for levels of gibberellins were skin, aril & seeds. In both years seed gibberellin level on 3 June (1981) & 12 June (1982) was significantly higher in cracked
than in normal fruits.

Sharma & Dhillon (1987) observed that panicles on that litchi cv. Dehradun were sprayed with various concentrations of ZnSO₄, GA3 on NAA at different intervals. Fruit cracking was reduced significantly with 25 ppm NAA & this was the best treatment. Application of 50 ppm GA3 more effective than ZnSO₄ effective than an interval of 11 or 15 days.

Sharma & Ray (1987) the factors considered were cracking stage and pattern, varietal susceptibility to cracking, temperature and humidity, anatomical factors, irrigation and rainfall, physiological factors, chemical composition of the fruit, control measures, supply of nutrients, use of growth regulators, and breeding of crack resistant cultivars.

Mishra & Khan (1981) suggested that the fruit-size was increased most by Zn at 0.4%, B at 0.4% reduced fruit cracking best of all and at 0.8% it resulted in the earliest fruit ripening (22-27 days). Fruit quality was best on trees treated with 2,4,5-T 10 ppm.

Sharma & Dhillon (1988) observed that the level was higher in the skin, arial & seed of cracked fruits than in the corresponding parts of normal fruits.

Li-Jian et al. (1999) was found the negative co-relation between the calcium content in litchi leaves & the rate of fruit cracking. The exchangeable calcium in the soil and the calcium contents in the leaves and fruit peel were significantly lowers in orchards where fruits developed severe cracking than in those where cracking was slight. The calcium content in cracked fruit was significant higher than that in normal fruits. Spraying with a solution containing calcium compound significantly increased the calcium levels in a leaves and fruit peel and significantly lowered fruit cracking rate. Water stress reduce
that calcium accumulation in fruit peel, specially during rapid aerial growth & thum increased in fruit cracking rate.

Bhat et al. (1997). The lowest fruit cracking (6.01% - 6.95%) was observed following treatment with 2,4-D at 20 ppm or NAA at 50 ppm. Some plant growth regulators treatments promoted fruit drop, but all treatments promoted fruit set. Fruit cracking, TSS and acidity has encouraging results with 2,4-D at on fruit set & fruit drop. Foliar application of NAA at 40 or 50 ppm were recommended to promote fruit set and reduce fruit drop.

Vieira et al. (1996) observed that the fruit growth and development of litchi during growth season in vicosa, state of Minas Gerais, Brazil. From panicle flowering to about 45 days after flowering (DAF), 95% of fruit fresh weight was due to the seed & skin. Fruit weight thousand exponentially from 45 to approximately 80 DAF, but lower increases were observed until 104 DAF. At a later stage of drope development, the aril accounted for 60% of fruit fresh weight, while 14% consisted of seed and 26% skin. Soluble solid reached maximum value at about DAE becoming what stable afterwards. Acidity, on the other hand, dropped from 6.0% at 45 DAF to 0.6% at 89 DAF onwards. Mature red fruit lience present 89 DF from panicle floweing but after 104 DAF fruit skin become drown.

Ghosh et al. (1989) observed that the fruit weight, specific gravity, TSS total sugar & TSS : acid and sugar : acid ratio of both cultivars increased through out the period of fruit development & growth following a single sigmoid curve. Starch titratable acidity & ascorbic acid content increased during early stages of fruit development but declined on maturity. At harvest maturity, fruit weight sugar & DM contents were higher & stone weight was lower in Elachi than in Bombay.
Zheng-Xiao et al. (1995) observed that the plant grew strongly and had thick leaves. Fruit set, fruit weight & yields/plants was increased (increases in yields of cultivars lanzhee, wye, Bendizhong & Chike of 91, 10.61 and 46% resp.). Fruit quality of Shuish hang longar was improved (43% increase in vitamin C content & increases in soluble solids & sugar contents).

Patel et al. (1998) reported that the fruit yield and fruit quality were improved in all treatment compared with the control (no fertilizer). Ferrous sulfate (108g Fe/tree), salfuric acid (719 and 1439g s/tree) & elemental sulfur (1800g S/tree) treatments gave significantly higher fruit yield & improved the quantity compared.

Sunil Kumar et al. (1995) recorded that spraying with 1.0% zinc Sulfate or 2.0% potassium chloride produced the best fruit chemical composition in terms of TSS content, sugar acid ratio & ascorbic acid content.

Hasan & Jana (2000) suggested that Application of 1.0 % ZnSO₄ significantly increased total soluble solids, total sugar, reducing sugar & pH content of fruit juice with a considerable reduction in acidity apart from ZnSO₄ (1.0 %) CuSO₄ (1.0 %) was also found effective in improving TSS & total sugar contents of fruits.

Thakur et al. (1991) observed that treatment with 25 ppm 2.4.5-T resulted in the highest ratio of edible : non-edible parts. TSS and total sugar, lowest acidity, in fruit of both cultivars, closely followed by treatment with 50 ppm GA3. The highest ascorbic acid content was obtained with 50 ppm GA3, closely followed by 25 ppm 2.4.5-T MH. CCC & ethephon treatments had little effect on fruit composition.
Jain -BP et al. (1985) observed that the highest juice percentage (47.16%) & fruit ascorbic acid content (41.1 mg/100 CC) was obtained with NAA at 10 ppm & TSS (18.6 mg/100 CC) with 2,4,5-T at 25 ppm & with Zn + B (18.04 mg/100 CC).

Singh & Brahmachari (1999) suggested that size of fruit increased greatly when borax and potassium chloride were sprayed. Fruit quality as evident by TSS & sugar content was enhanced markedly by the application of boron and Zinc. The effect of molybdenum was less prominent. The ascorbic acid content of the fruit pulp also increased greatly with the higher concentrations of boron & zinc.

Peliser et al. (1999) observed that total soluble solids were lowest with Zn omitted.

Samunder Singh et al. (1992) recorded that significantly increased fruit yield, number of fruits per plant, fruit yield per hectare and TSS with the application of zinc sulphate 15 kg./ha. and boron 7 kg./ha as basal in addition to the normal fertilizer. A foliar spray of 0.5% zinc sulphate plus 0.1% borax effected a Similar result.

From the foregoing studies at appears that application of zinc increased yield and quality of fruits and acidity is decreased due to application of this element. It is also clear that zinc application is responsible for checking fruit cracking which is deciding factor for judging the fruit price. It is also to remark that zinc application increased the biosynthesis of auxin by which good growth and regular and perfect flowering is governed.