Research Article IJAER (2018); 4(1): 185 - 189

International Journal of Agricultural and Environmental Research
FREE AND OPEN ACCESS
Available online at www.ijaaer.com
ISSN 2414-8245 (Online)
ISSN 2518-6116 (Print)

YIELDAND QUALITY OF TOMATO (*Lycopersicon esculentum* L.) AS INFLUENCED BY DIFFERENT CALCIUM AND MAGNESIUM CONCENTRATIONS

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Abstract

Atrial entitled"yield and quality of tomato (lycopersicon esculentum l.) as influenced by different calcium and magnesium concentrations" were conducted at Horticulture Research Farm, The University of Agriculture Peshawar. Calcium at the rate of (0%, 0.15%, 0.30% and 0.45 %,) and Magnesium at the rate of (0%, 0.04%, 0.08% and 0.12%) were applied as foliar spray using Randomized Complete Block Design with three replications. Maximum Number of flowers cluster^{-1} (5.96), number of fruits cluster^{-1} (4.45), fruit weight (79.04 g), fruits kg^{-1} (12.83), total yield (ton ha^{-1}) (22.83) was observed in plants with 0.30% Calcium application and number of defectives fruits (143.73) were observed in plants with control fertilizers condition. Similarly, maximum number of flowers cluster^{-1} (6.34), number of fruits cluster^{-1} (4.57) fruit weight (77.01 g), fruits kg^{-1}(12.68), total yield ton ha^{-1}(21.39) were observed in plants with 0.08% Magnesium application and number of defectives fruits (140.94) were observed in plants with control fertilizers condition. Among various treatments used Calcium and Magnesium at the rate of 0.30% and 0.08 % showed better result in most of the growth and yield parameters.

Key words: *Tomato, Calcium, Magnesium, Yield, Quality*

INTRODUCTION

Tomato (*Lycopersicon esculentum* L.) is one of the most important vegetable crops grown throughout the world under field and greenhouse conditions (Kaloo, 1986). Tomato is a major component in the daily diet of human in many countries, and an important source of minerals, vitamins, and antioxidants (Grierson and Kader, 1986). Tomato belongs to the family Solanaceae and it is believed to have originated in the coastal strip of western South America, from the equator to latitude of about 300 South. Growing tomato is not an easy task since the plant is exposed to many constraints (diseases, climate, nutrition, etc.), while the fruit itself has to meet certain market requirements. Three factors drive consumer's preference: physical appearance (colour, size, shape, defects, and decay), firmness and flavour (Jones, 1999). Of the three, appearance has the most immediate and profound effect on consumer choice, and for this reason, produce for the fresh market is principally graded on basis thereof (Cockshull *et al*., 1998). High yields combined with high fruit quality are a common requirement of tomato growers, and this can only be achieved if critical production factors are taken into consideration. These include proper irrigation management, variety choice, disease prevention, cultural techniques, soil fertility, climate, etc. Numerous authors have studied the effects of different plant nutrients on yield and quality of tomato and it becomes clear that some of these nutrients play a key role in tomato production. (Dorais *et al*., 2001).

Calcium is one of the most important mineral nutrients in tomato production. Calcium deficiency in tomato reduces leaf size, and causes necrosis of young leaves and yield loss in extreme cases (Adams and Holder 1992). Calcium is a major constituent of cell walls where it helps in maintaining cell wall integrity and membrane permeability; it enhances pollen germination and growth; it activates a number of enzymes for cell mitosis, division, and elongation, and it affects fruit quality (Jones, 1999). Plant Ca deficiencies are frequently restricted to low transpiring, fast growing tissues such as shoot apex, fruits, and storage organs. Calcium deficiency may lead to early senescence and absence of fructification. Seeds that are deficient in Ca generally have poor germination and produce abnormal, weak seedlings, even when seed are germinated in a complete and balanced nutrient containing media (Taylor and Locascio, 2004). Since most mineral soils are rich in available Ca, deficiency occurs infrequently in plants but an undersupply of Ca to fruit and storage tissues may occur (Mengel and Kirkby, 2001).

Magnesium, a major constituent of cell walls (Jones, 1999), is vital for the process of photosynthesis and therefore for the life of the plant in general (Bergmann, 1992). Besides its function in the chlorophyll molecule, Mg2+ is required in other physiological processes (Mengel and Kirkby, 2001), especially those implicated in the synthesis and maintenance of chlorophyll. Apart from its implication in photosynthesis, Mg is of importance mainly as co-factor and activator of many enzyme and substrate transfer reactions (Bergmann, 1992). The functions of Mg in plants are mainly related to its capacity to interact with strongly nucleophilic ligands through ionic bonding, and to act as a bridging element and form complexes of different stabilities (Marschner, 1995). Magnesium also appears to stabilize the ribosomal particles in the configuration necessary for protein synthesis and is believed to have a similar stabilizing effect in the matrix of the nucleus (Mengel and Kirkby, 2001). Magnesium has an effect on leaf osmotic potential, which decreases with increasing concentrations of this element in the nutrient solution (Carvajal *et al*., 1999). Increased Mg levels in the nutrient solution increase Mg levels in the plant and decrease fruit dry matter (Gunes *et al*., 1998). There is no single value as to the optimum concentration of Mg in the nutrient solution in greenhouse tomato fertigation (Chapagain *et al*., 2003). Jones (1999) stated that the best concentration of Mg is between 2.5-5.83 mM of Mg2+. Chapagain *et al*. (2003) reported that 3.3-4.17 mM Mg2+ is optimal for greenhouse tomato production in Israel. A supply of 4 mM Mg2+ in a peat-based growth resulted in maximum plant growth and high yields (Bryson 10 and Barker 2002) whereas the best overall yield and quality in rockwool grown tomato were given as 4.16-6.7 mM of Mg2+ by Hao and Papadopoulos (2003). Once again, one of the reasons behind this variation in recommendations is the fertigation system that is used.

In view of above facts the study was carried out to investigate the effect of calcium and magnesium levels on yield and yield components of tomato and to evaluate optimum level of calcium and magnesium for maximum growth and yield of tomato.

MATERIAL AND METHODS

An experiment "yield and quality of tomato (*Lycopersicon esculentum* L.) as influenced by different calcium and magnesium concentrations" was conducted at Horticulture Research Farm, The University of Agriculture Peshawar. The actual experimental plot was ploughed thoroughly before transplanting of the seedlings and well rotten farm yard manure was incorporated in the field. Forty eight sub plots were prepared for transplantation of seedlings row to row and plant to plant distance were kept 100 cm and 30 cm respectively. The experiment was laid out in randomized complete block design (RCBD) with two factors. The experiment contained 16 treatments which were repeated three times. Calcium chloride was used as a source for calcium, while magnesium sulphate was used as source for megnesium. From 1 kg of calcium chloride we were taking 0.15%, 0.30% and 0.45%, concentration of calcium and also from 1 kg of magnesium sulphate 0.04%, 0.08% and 0.12%. concentration of boron and was applied as a foliar application after one month of transplantation. Plants were regularly observed and the data on growth parameters of Tomato was recorded on Number of Flowers Cluster^{-1}, Number of FruitsCluster^{-1} , Fruit weight (g), Number of Fruits kg^{-1}, Number of Defectives Fruit and Total yield (ton ha^{-1}).

RESULTS

Number of Flowers Cluster^{-1}: The statistical analysis showed that folair application of calcium (Ca) and magnesium (Mg)and Ca x Mg interaction significantly affected number of flowers cluster^{-1} (Table 1).Higher number of flowers cluster^{-1} (5.96) were counted in 0.30% Ca applied plots while lower number of flowers cluster^{-1} (4.86) were counted in control plots (Nill level of all treatments). Moreover, number of flower cluster $^{-1}$were higher (6.34) in 0.08% Mg treated plots while lower numbers of flowers cluster-1 (4.52) were counted in control plots. Interaction study showed that maximum number of flowers cluster^{-1} (6.64) was observed in case of foliar application of calcium and magnesium at the rate of 0.30% and 0.08 % correspondingly. This increase in number of flowers cluster $^{-1}$ is due to improved vegetative growth and better health of plant.

Number of FruitsCluster^{-1}: The statistical analysis showed that foliar application of calcium (Ca) and magnesium (Mg) and Ca x Mg interaction significantly affected number of fruit cluster^{-1} (Table 2). Maximum number of fruits cluster^{-1} (4.45) were recorded with 0.30% Ca applied plots while lower number of fruits cluster^{-1} (3.36) was observed in control plots (Nill level of all treatments). Moreover maximum number of fruits cluster^{-1} (4.57) was observed in 0.08% Mg treated plots while the lower number of fruits cluster^{-1} (3.42) was observed in control plots. Interaction study indicates that the maximum number of fruits cluster^{-1} (5.30) was observed in case of interaction of Ca and Mg at the rate of 0.30% and 0.08 % correspondingly. This increase in mainly associated with higher number of flowers.

Fruit weight (g): The statistical analysis showed that folair application of calcium (Ca) and magnesium (Mg) and Ca x Mg interaction significantly affected fruit weight (g) (Table 1). Maximum fruit weight (79.04g) was observed in 0.30% Ca applied plots while minimum fruit weight (69.23g) was observed in control plots (Nill level of all treatments). Moreover, maximum fruit weight (77.01g) in 0.08% Mg treated plots while decrease fruit weight (68.99g) was observed in control plots. Interaction study indicated that the maximum fruit weight (84.13g) was observed in case of foliar application of Ca and Mg at the rate of 0.30% and 0.08 % correspondingly.

Number of Fruits kg^{-1}: The statistical analysis showed that foliar application of calcium (Ca) and magnesium (Mg) and Ca x Mg interaction significantly affected number of Number of fruits kg^{-1} (Table 1).Maximum number of fruits kg^{-1}(12.83) was observed in 0.3% Ca application and minimum fruits kg^{-1}(10.89) was noted in control plots (No Ca application). In case of Mg application maximum number of fruits kg^{-1} (12.68) was observed in 0.08% Mg application and minimum number of fruits kg^{-1}(11.04) was observed in control plots. Interaction study showed that the maximum number of fruits kg^{-1} (13.63) was observed in case of Ca and Mg application at the rate of 0.30% and 0.08 % correspondingly. This increase in number of fruits kg^{-1} is due to high fruit weight.

Number of Defectives Fruit: The statistical analysis showed that foliar application of calcium (Ca) and magnesium (Mg) and Ca x Mg interaction significantly affected number of Number of defective fruits (Table 1). The highest number of defectives fruit (143.74) was observed in control plots while the lowest number of defective fruits (132.26) was noted in 0.30% Ca application. In case of Mg highest number of defectives fruits (140.94) was observed in control plots and the lowest number of defectives fruits (133.36) was observed in 0.30% Ca application. In interaction study highest number of defectives fruits (145.87) were observed in case of control plots.

Total yield (tons ha^{-1}): The statistical analysis showed that foliar application of calcium (Ca) and magnesium (Mg) and Ca x Mg interaction significantly affected Total yield (tones ha^{-1}) (Table 1). .Maximum total yield ton ha^{-1}(22.83) was observed in 0.30% Ca application while minimum total yield ton ha^{-1} (17.18) was observed in control plots .In case of Mg maximum total yield tonha^{-1} (21.34) was observed in 0.08% Mg application and minimum total yield ton ha^{-1} (18.66) was observed in control plots. Interaction study indicates that the maximum total yield ton ha^{-1}(24.41) was observed in case of interaction of Ca and Mg at the rate of 0.30% and 0.08 % correspondingly.This increase in total yield (ton ha $^{-1}$) was mainly associated with Number of fruits plant $^{-1}$, and number of fruits kg $^{-1}$.

Table 1. Flowers cluster^{-1}, number of fruits cluster^{-1}, fruit weight, fruits kg^{-1}, number of defective fruits and total yield (ton) ha^{-1} as influenced by different concentrations of calcium and magnesium.

Treatments (Calcium Levels)	Number of flowers cluster^{-1}	Number of fruits cluster^{-1}	Fruit weight (g)	Number of Fruits kg^{-1}	Number of Defectives Fruit	Total yield (ton ha^{-1})
C1	4.86d	3.36 c	69.23 d	10.89 c	143.73 a	17.18 d
C2	5.36 c	3.65 c	71.55 c	11.68 b	136.72 b	18.97 c
C3	5.96 a	4.45 a	79.04 a	22.83 a	132.25 c	22.83 a
C4	5.75 b	4.15 b	73.53 b	21.04 b	133.46 d	21.04 b
LSD	0.1474	0.1049	0.4476	0.3448	0.3086	0.1100
Magnesium Levels						
Mg1	4.52 d	3.42 d	69.99 d	11.04 d	140.94 a	18.66 d
Mg2	5.27 c	3.62 c	72.58 c	11.62 c	137.67 b	19.54 c
Mg3	6.34 a	4.57 a	77.01a	12.68 a	133.36 d	21.34 a
Mg4	5.79 b	4.00 b	74.74 b	12.02 b	134.22 c	20.49 b
LSD	0.1474	0.1049	0.4476	0.3448	0.3086	0.1100
Interactions Ca*Mg						
Significance level	*	*	*	*	*	*

DISCUSSION

Calcium and magnesium are two important micro nutrients which are important in plant life cycle to perform various functions, like magnesium is the main component of the chlorophyll, magnesium also helps in speed up the enzyme activity and play important role in energy transport reactions Hao and Papadopoulos (2003). Calcium is the main component of cell walls and it plays a key role in sustaining. cell wall consistency and membrane permeability. Calcium improves to increase the growth and development of the plant as well as pollen germination. Calcium also increase the speed of enzyme to increase mitosis, cell splitting as well as to increase the size of the cell and produce more fruit of good quality to increase the yield of tomato crops (Taylor and Locascio, 2004). Farmers in Pakistan areun aware of the importance of micro nutrients they just rely on macro nutrients, in view of their importance present study was carried out to investigate the yield of tomato as influenced by different concentrations of calcium and magnesium.

Present investigation showed that both Ca and Mg significantly affected the yield components of tomato. Result showed that tomato plants sprayed with 0.30 % Ca produced maximum number of flowers cluster^{-1}, number of fruits cluster^{-1} , fruit weight, fruits kg^{-1} , total yield (ton ha^{-1}) while maximum number of defective fruits was found under control plots. In case of Mg maximum number of flowers cluster^{-1}, number of fruits cluster^{-1}, fruit weight, fruits kg$^{-1,}$ and total yield (ton ha^{-1})) were produced when Mg was applied at 0.08% , while maximum number of defective fruits was recorded in control plots , these results are supported by Usten *et al*., (2006) who found that application of Ca not only increase resistance against pathogens, decreased the disease due to bacteria but also increase the fruit weight and due to increase in fruit weight the yield of tomato crop also increased.

Hao *et al*., (2004) applied two levels of calcium i-e. 150 mg L^{-1} and 300 mg L^{-1} on tomato crop. He recorded maximum number of flower, number of fruits, better fruits quality, total yield as well as control the physiological disorder of blossom end rot at 300 mg L^{-1} as compare to 150 mg L^{-1}. The study of Bradfield and Guttridge (2002) concluded that Calcium deficiency symptom will often appear in the form of thickened, wilted, or curled leaves; a thickened cracked or water socked condition of petioles and stem; and a discoloration, cracking, or rotting of fruit, tubers, and roots. Due to magnesium deficiency the interveinal chlorosis take place in the leaflets of the older leaves. The chlorosis starts from the margins and then extends to the fine vein and at the last the entire leaf become yellow.Due to the deficiencies of these nutrients sometime abnormities and disease occurs i-e blotchy ripening (BR), catfacing (CF), fruit cracking (FC), and blossom-end rot (BER).

CONCLUSION

It is observed from the research experiment that the application of calcium at the rate of 0.30% and magnesium at the rate of 0.08% showed maximumreproductive growth in tomato and hence should be sprayed on tomato crops to achieve maximum yield.

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