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EFFECT OF MAGNESIUM APPLICATION ON CHLOROPHYLL CONTENT AND YIELD OF TOMATO

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Abstract

Field experiment two year was conducted at Indian Institute of Horticultural Research, Bangalore to study the different levels of magnesium application on yield and chlorophyll content of tomato. The Mg applied significantly increased the leaf chlorophyll content of tomato plants. Total chlorophyll content in both the years at second and fourth harvest stages was significant. The yield of tomato was significantly increased with the application of magnesium sulphate at graded levels. Highest fruit yield of 78.01 t ha^{-1} was recorded at treatment T_3, where 50 kg mg/ha^{-1} was applied to soil. It was evident from the experiment during two years that increased level of application of magnesium to tomato crop increased the chlorophyll content and also the fruit yield significantly.

Key words : Chlorophyll content, tomato, yield, leaf tissue.

Introduction

Tomato is one of the important vegetable crops grown throughout the world under open and controlled conditions. It serves as a daily component of diet in many countries and also an important source of minerals, vitamins and antioxidants (Grienrson and Kader, 1986). Many workers have studied nutritional aspects of tomato, which is vital in its production. Potassium, Mg and Ca play an important role in nutritional management of tomato and strongly interfere each other in absorption mechanism (Hao and Padoponals, 2003).

In general Ca and Mg are available in sufficient quantity in neutral, alkaline soils and soils with high CEC. Mg is low in acidic, high textured and low organic matter containing soils. A soil having less than 15 per cent of CEC occupied by exchangeable Mg are considered to be deficient in Mg (Biswas *et al.*, 1985), crops grown on these soils show Mg deficiency and sensitive crops respond to applied magnesium. Generally, Mg deficiency has been observed in acidic soils and in crops like F_1 hybrids with high productivity per unit area with great demand for Mg. These soils are sandy loam or clay loam texture, low in organic carbon and soil pH will be below 6.00.

The present day tomato hybrids yield as high as 120 t ha^{-1}. In order to realize such high yields there is need to supplement all nutrients in right proportions at right time. The current nutrition management does not include secondary nutrient like Ca, Mg and S even though they play a vital role. Magnesium is a major constituent of chlorophyll molecule and enzyme activator for a number of energy transfer reactions. Its deficiency in hybrid tomatoes is increasingly reported by many research workers.

The visible symptoms of Mg deficiency in tomato leaf tissue are quite characteristic and probably the most early recognized. Mg deficiency is generally noticed in older leaves with inverted "V" shape chlorosis and later become abnormal. In severe cases the inter-veinal chlorosis starts on the lower leaves of the plants, leaves become purplish red and, then leaves become brittle with a tendency to curve upward, and shed prematurely. Thus it is evident that F_1 hybrids of tomato have very high demand for Mg and are prone to Mg deficiency. In this study the effect of different levels of Mg application on chlorophyll content and yield of tomato was studied. Osman *et al.* (1985) noticed an increase of 27.9 per cent yield in tomato by the application of 56 kg Mg ha^{-1}. Hao and Papadopolus (2004) studied different levels of Ca and Mg on tomato fruit yield, where they have observed the chlorophyll content of middle and bottom leaves

increased with decrease in Mg concentration in nutrient solution. High level of Ca in nutrient solution increased the chlorosis due to its competition with Mg uptake due to antagonism between Ca and Mg (Paiva *et al.,* 1998).

The objective of this study was to quantify the response of high yielding F_1 hybrid tomato to external application of Mg in acid Alfisols on chlorophyll content and fruit yield.

Materials and Methods

The experiment was conducted at the Research Farm of Indian Institute of Horticultural Research, Hesaraghatta, Bangalore, for two years during the winter season of 2010-11 and 2011-12. The experiment was laid out in Randomized Block Design in triplicate with five treatments. *viz.* **T_1**- control –RDF [180:150:120 NPK kg ha^{-1}], **T_2** - RDF+$MgSO_4$ (25 kg ha^{-1}), **T_3** - RDF+$MgSO_4$ (50 kg ha^{-1}), **T_4** - RDF+$MgSO_4$ (75 kg ha^{-1}), **T_5**- RDF+$MgSO_4$ (100 kg ha^{-1}) RDF comprised of 180:150:120 N:P_2O_5:K_2O kg ha^{-1}. Fifty per cent of nitrogen and full dose of phosphorus and potassium were applied at transplanting, as per treatment, in the form of ammonium sulphate, Single Super Phosphate (SSP) and muriate of potash. The remaining 50% of nitrogen was applied in two equal splits (at 25 days after transplanting, and 25% at 50 days after transplanting), Magnesium was applied in the form of magnesium sulphate ($MgSO_4$ $7H_2O$). Quantity of magnesium applied as magnesium sulphate is given in table 1.

Table 1 : Quantity of $MgSO_4$ applied for supplying different doses of magnesium.

Treatment levels of magnesium (kg ha^{-1})	Quantity of $MgSO_4$ levels of magnesium (kg ha^{-1})
25	257
50	514
75	771
100	1028

Tomato hybrid Arka Ananya was transplanted at a spacing of 100cm x 60cm. Tomato fruits are harvested in seven pickings.

Estimation of leaf Chlorophyll:

Chlorophyll was extracted by a non maceration method using dimethyl sulfoxide (DMSO) (Thimmaiah, 1999). Hundred mg of leaf and 250 mg of bract samples were placed in tubes and 10 ml of DMSO were added to it. The tubes were incubated in an oven at 65^0C for 3 hours. Subsequently, after cooling and shaking, the absorbance was read at 663nm and 645 nm in a Spectrophotometer. The amount of chlorophyll a, b and total chlorophyll were calculated by using following formulae (Arnon, 1949).

mg of chlorophyll a/g sample = [1.27 x (1)663D - 2.69 x 645 D] x V/1000xW

mg of chlorophyll b/g sample = [22.9 x (1)645D - 4.68 x (1) 663 D] x V/1000xW

mg of total chlorophyll /g sample = [22.7 x (1)645D +8.02 x 663 D] x V/1000xW

Where, D is the measured optical density at respective wave length

V- Volume of DMSO

W- Weight of sample

Tomato yield

The weight (kg) of fruit harvested from each plant at each picking was recorded separately and expressed in kg. The yield of fruits from each picking was pooled and reported as fruit yield in kg per hectare.

Statistical analysis

The data on various observations such as growth, yield and quality parameters were tabulated and subjected to statistical analysis as described by Sundaraj *et al.*, 1972. The statistical analysis was carried out using the "Biostat-IIHR" programme and also by using the "SAS" programme.

Results and Discussion

Total chlorophyll

Magnesium is a component of chlorophyll and occupies the central point in the biochemical structure. Hence one can expect significant relationship between applied Mg and chlorophyll content of tomato. The total chlorophyll content at second and fourth harvest stages as influenced by different level of Mg application found significant with lowest chlorophyll content in control plots (T_1 kg Mg ha^{-1}) and the highest in T_5 treatment (100 kg Mg ha^{-1}) at second and fourth harvest stages. Further it is observed in general that the chlorophyll content increased with the increased level of Mg application. As Mg is an integral part of chlorophyll, graded application of Mg to soil increased chlorophyll content in plants. Hao and Papadopoulos (2004) studied the different levels of Ca and Mg in nutrient solution on tomato fruit yield, where in they have observed the chlorophyll content levels increased with the increasing concentration of Mg in nutrient solution. In a study, effect of magnesium chloride as a partial source of potassium in fertigation experiment

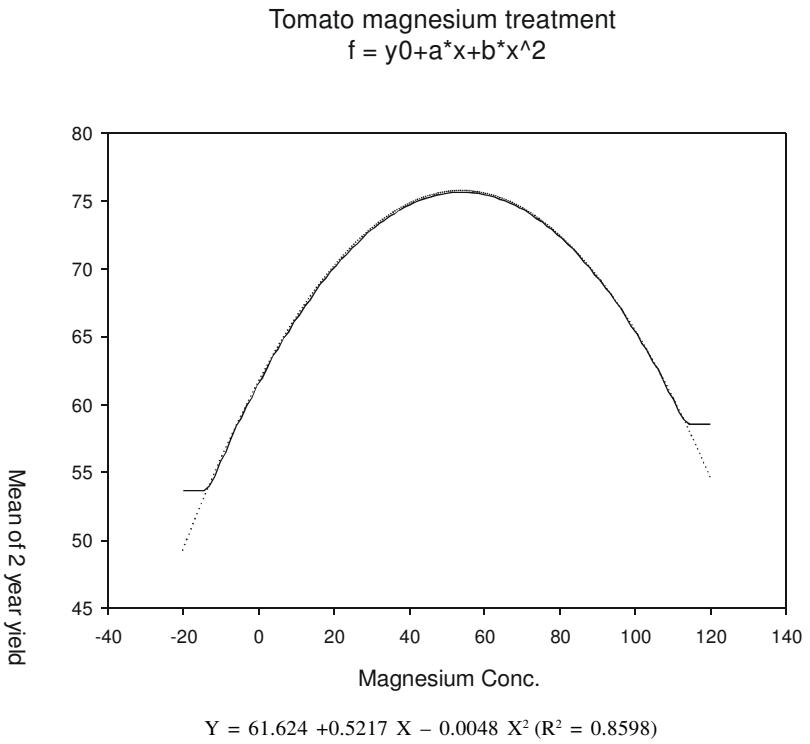

Fig. 1 : Tomato two year mean yield as influenced by magnesium levels in soil.

Table 2 : Effect of magnesium application on total chlorophyll content (mg 100 g^{-1} fresh weight) in tomato hybrid (Arka Ananya).

Treatment	At second harvest			At fourth harvest		
	I year	II year	Mean	I year	II year	Mean
T_1 (0 kg Mg ha^{-1})	1.64	1.47	1.56	1.63	1.65	1.64
T_2 (25 kg Mg ha^{-1})	1.89	1.68	1.79	1.71	1.75	1.73
T_3 (50 kg Mg ha^{-1})	1.82	1.72	1.77	1.76	1.77	1.76
T_4(75 kg Mg ha^{-1})	1.90	1.86	1.88	1.87	1.89	1.88
T_5 (100 kg Mg ha^{-1})	1.98	1.90	1.94	1.90	1.95	1.92
S. Em±	0.047	0.068	0.056	0.063	0.057	0.067
C.D at 5%	0.13	0.22	0.138	0.20	0.19	0.163

on tomato revealed total chlorophyll was highest in KCl+kel $MgCl_2$ treatment than in KCl treatment alone. Bishnu *et al.* (2003) also reported similar results. Anathanarayana and Venkata Rao (1980) observed similar results on maize in Alfisols of Karnataka.

Fruit yield

Total mean yield of tomato fruits differed significantly among different treatments during the two years of experimentation. Applied Mg as $MgSO_4$ @ 50 kg ha^{-1}significantly enhanced the fruit yield. Application of higher levels of Mg decreased the fruit yields, but the yield levels were higher than plots without Mg application (T_1-control) (table 1). The mean of two year pooled data revealed that lowest tomato yield was observed in the control treatment- (60.09 t ha^{-1}). On the other hand, highest yield was observed in T_3- RDF+$MgSO_4$ 50kg/ha (78.01 t ha^{-1}), which is also on par with T_2-RDF+$MgSO_4$ 25kg/ha (73.92 t ha^{-1}) followed by T_4-RDF+$MgSO_4$ 75kg/ha (68.12 t ha^{-1}) and T_5-RDF+$MgSO_4$ 100kg/ha (67.80 t ha^{-1}).

Tomato responded significantly to applied Mg in terms of fruit yield, number of fruits and weight of fruits. As the level of applied Mg increased the tomato yield, number of fruits and the weight of the fruits increased and attained

Table 3 : Yield (t ha^{-1}) of tomato crop (Arka Ananya) as influenced by different levels magnesium treatments.

Treatment	Tomato fruit yield		
	I year	II year	Mean
T_1 (0 kg Mg ha^{-1})	59.103	61.080	60.090
T_2 (25 kg Mg ha^{-1})	74.597	73.243	73.920
T_3 (50 kg Mg ha^{-1})	77.527	78.487	78.010
T_4(75 kg Mg ha^{-1})	68.223	68.020	68.120
T_5 (100 kg Mg ha^{-1})	68.097	67.493	67.800
S.Em±	2.6800	2.470	1.935
C.D at 5%	8.7540	8.073	6.310

a maximum and declined beyond a particular point, based on which regression equations were developed between applied Mg and fruit yield. The best fit equation ($Y= 61.624+0.5217 X–0.0048 X^2$, $R^2= 0.8598$) is presented in fig. 1. From this regression equation, it was found that tomato yields maximum at 54.2 kg applied Mg and at this level of applied Mg tomato can yield 75.6 t ha^{-1}. Upendra *et al*. (2003) observed that application of Mg is essential along with other major nutrients to obtain economic yields of tomato. Osman *et al.* (1985) also obtained significant yield at 56 kg Mg ha^{-1} on an acidic soil. Bose *et al.* (2006) reported that tomato yield increased when potassium magnesium sulphate (K_2So_4, $2MgSo_4$) was applied as compared to use of only potassium chloride. Hao and Papadopoulos (2004) found that for green house tomatoes to obtain higher yield application of 80 ppm of Mg is essential (table 3).

Magnesium conc.= 54.2 , Mean yield (y) = 75.6287

Conclusion

The two year field experiments showed that hybrid tomato yield can be significantly increased by the soil application of magnesium up to 50 kg mg ha^{-1}. Application of magnesium enhanced the total leaf chlorophyll resulting in enhanced levels of photosynthesis leading to higher yields.

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