J. Phytol. Res. **18**(2) : 215-218, 2005

ROLE OF COPPER AND MANGANESE APPLICATION ON VARIOUS PIGMENT LEVELS OF *ZINGIBER OFFICINALE* ROSC. VAR-1

A. KSHERODA DEVI and P.K. SINGH
Department of Life Sciences, Manipur University, Canchipur, Imphal-795003, Manipur, India.

Field experiments were carried out during the period of April to December 2002 and 2003 to improve the qualitative and quantitative characters of ginger (*Zingiber officinale* Rosc.)VAR-1 with soil and foliar application of copper ($CuSO_4$) manganese ($MnSO_4$) and combination of the two as total micronutrients (TM) at different concentrations, in a randomized block design. Estimation of chlorophyll from the fresh leaf samples of various treatments was done at four intervals of 90, 120, 150 and 180 days after plantation (DAP). The concentration of total chlorophyll (T-chl) and chlorophyll b (chl-b) were found to be highest at the early growth stage but the concentrations of chlorophyll a (chl-a) and carotenoid (ca) were found to be highest at the latter growth stages. Among the treatments, minimum level was recorded in control stages (T_1). In order to enhance the yield, micronutrients play an important role in carotenoid and chlorophyll levels, both in soil and foliar sprayed plants.

Keywords : Ginger; Micronutrients; Soil and foliar application.

Introduction

Micronutrients play specific roles that enhance the production of vegetables. Wallace and Romney[1] reported that due to synergistic trace metal effects in plants, any individual trace elements, when supplied at low or high quantity, affects the concentration of other elements in plants. The most well known example of the involvement of manganese is in an enzyme protein of the water splitting system associated with PSII and in its deficiency, the functioning of the protein is impaired[2], thus affecting photosynthesis. In severe manganese deficiency, a decrease in chlorophyll content along with disturbances in ultra structure of thylakoids have been reported as a consequence of inhibition of carotenoid biosynthesis in such condition. Copper acts as a prosthetic group of the enzymes. It is also a component of plastocyanin, which takes important role in electron transport system in photosynthesis. Copper deficiency causes curling of young leaves. The present study is to investigate the effect of various concentrations of Mn , Cu and TM in ginger (*Zingiber officinale* Rosc. L.)VAR-1, cultivation.

Materials and Methods

The experiment was conducted at the Life Sciences Experimental field, Manipur University Campus, during the period of April to December 2002 and 2003. The plot was laid out in a randomized block design (RBD) with four replications each having a plastic bag (size 15 cm diameter, 8cm height and 2 kg soil capacity) and spacing of 15cm. The size of the experimental area is 6.3m length and 1.75m breadth. Number of plots were 24 with 6 treatments and a population of 240 plants. Application of micronutrients were performed on soil and foliar (40 and 70 DAP). The treatments are T_1 (control without micronutrients), T_2 (with copper- 0.012 g/ bag), T_3 (manganese - 0.12g/bag). Foliar application was done with 0.05% of spraying reagents Cu, Mn and TM (0.05% : 0.05%); they are T_4, T_5 and T_6 respectively. Estimation of chl / and ca / were done by the methods of Arnon[3] and Jayaraman[4]. Representation and statistical calculations were made by following the techniques of Cochran and Cox[5] and Gomez and Gomez[6].

Results and Discussion

The levels of T- chl in the fresh leaves of test plants were variable. In 90 DAP and 150 DAP, the highest T-chl concentrations were 0.673 mg/g and 0.346 mg/g respectively and occurred when the plant received the treatment T_6 (Total micronutrients in foliar sprayed plants). At 120 and 180 DAP, the highest T-chl value was observed in T_4 (plants treated with copper as foliar spray) i.e. 0.311 mg/g and 0.470 mg/g. The lowest T-chl concentration was recorded by plants in T_1 (control without micronutrients) in all age groups (Table 1).

The concentration of chl - a was highest in T_4 (Cu in foliar sprayed plants) at 90, 120 and 180 DAP. At 150 DAP, the highest concentration of chl - a was observed in T_6. The lowest concentration of chl- a was observed in T_1 (control without micronutrients) in all stages (Table 2).The levels of chl- b decreased from 90 to180 DAP. The highest chl- b was observed in T_6 i.e. 0.526 mg/g at 90 DAP. At 120 DAP and 180 DAP, the concentrations of chl- b were observed highest in T_2 (Cu in soil treated plants) i.e. 0.170 mg/g and 0.143 mg/g. At 150 DAP, the highest concentration of chl- b was observed in T_4 (Cu foliar sprayed plants) i.e.

0.182 mg/g. The lowest concentration of chl-b was observed in control in all treatments (Table 3).The levels of ca increased gradually from 90 to 180 DAP. The concentration of ca was observed highest in T_4 (Cu in foliar sprayed plants) at 90 and 180 DAP. At 120 and 150 DAP, the highest concentrations were observed in T_6(Total micronutrients in foliar sprayed plants). The lowest concentration of ca was observed in control in all treatments (Table 4).

Chlorophylls are the plant pigments present in the chloroplast of the cells. They are responsible for the process of photosynthesis of plants which is one of the most important vital metabolic processes of the plants. The rate of photosynthesis is governed by the chlorophyll level as well as the presence of appropriate amount of precursor molecules which are associated with number of elements such as Mg^{2+}, Fe^{2+} etc.

In the present investigation, the highest accumulation of T-chl and chl- b are found in T_6(TM in foliar sprayed plants). Then the accumulation of chl- a was found in T_4(Mn in foliar sprayed plants). Mn^{+2} has been reported to increase the enzyme activities[7]. Cu plays an important role in electron transport system of photosynthesis.

In all cases there is a gradual decrease in chlorophyll content as the plant get ageing 120 to 180 DAP. At 90 DAP, the highest accumulation of T-chl and chl- b were found in treatment T_6(TM in foliar sprayed plants) with 0.673 mg/g and 0.526 mg/g respectively. In chl- a, highest accumulation was found in T_4 (Cu in foliar sprayed plants) with 0.166 mg/g.

Manganese plays an important role in splitting of water associated with PSII and in its deficiency the functioning of protein is impaired[2] thus affecting photosynthesis. Increased chlorophyll content and the presence of efficient photosynthetic electron transport system could be an indication of increased photosynthesis. At 120 DAP, highest accumulation of T- chl , chl- a and chl- b were found in T_4 and T_2 with 0.311 mg/g 0.183 mg/g and 0.170 mg/g respectively. At 150 DAP highest is found in T_6 for chlorophyll a and T-chl with 0.206 mg/g and 0.346. But for chl- b, highest accumulation is found in T_4 with 0.180 mg/g. At 180 DAP, highest accumulation for T-chl and chl-a are found in T_4 with 0.470mg/g and 0.284 mg/g respectively. For chl- b, highest is found in T_2 with 0.143 mg/g. In the present finding, total micronutrients (TM) plays an important role in the synthesis of T-chl , chl- a and chl- b at the early stages. But at the latter stage, T_4 (Cu in foliar sprayed plants) are more distinctive then the combined one. This may be due to functional importance of individual micronutrients in various enzymatic reactions.

These findings are in agreement with the finding of Miziorko and Lorimer[8] and Sorte *et al.*[9].The effect of plant growth regulators and micronutrients on chlorophyll was studied by Meyyappan *et al.*[10]. Miller *et al.*[11] reported that in Fe deficient plants, ferredoxin would be limiting and could directly affect chlorophyll synthesis.

Increased chlorophyll content due to NAA application is recorded by Mohamed Yasin[12] in cotton, and by Karthikeyan[13] in groundnut. Plant growth regulators had increased the photosynthetic rate[14,15].

Carotenoids are the pigments involved in the initial absorption of water, which ruled as an environmental factor of growth and development. The result of brown colouration or less greenery on the surface of leaves may be a consequence of the formation of carotenoid pigments. The finding was in agreement with the depicted results of earliar workers[16].

Regarding the carotenoid content, it is found to be highest in T_4 at 90 and 180 DAP with 2.036 mg/g and 2.886 mg/g. At 120 and 180 DAP, highest accumulation of carotenoid are found in T6 with 1.964 and 1.493 mg/g respectively.

The present finding indicates the role played by Mn and TM in the different stages of growth phase of the test crop. Carotenoid signify the enzymes viz. catalase, peroxydase and the cytochrome, which have increased electron transport in proteins in photosynthesis[17]. Mishra and Shrivastava[18] reported that the supply of inorganic nitrogen prevents degradation of chlorophyll and carotenoid in maize leaves. Nieman and Paulson[19] studied the alleviation of carotenoid level by either form of nitrogen indicated structural requirement of chloroplast which might be deformed under salinity.

In the present study chlorophyll and carotenoid accumulation in various treatments particularly in T_6 and T_4 indicates the suitable treatment in ginger crop. The general objectives of this experiment is to forcast the yield of the crop. So in T_6 treatment maximum photosynthate will be available because of the maximum level of chlorophyll. In the two treatments T_6 and T_4 highest concentration and accumulation of chlorophyll was observed . From the above findings it can be concluded that the maximum crop yield will be in the two treatments (T_6 and T_4).

The application of micronutrients on ginger become important for the efficient utilization and better performance of the crop[20]. It is thus suggested that Mn application ($MnSO_4$ as a source)such as combination with Cu ($CuSO_4$ as a source) may counteract the toxic effect of Copper sulphate in the leaves of *Zingiber officinale*, has been in aggrement with the observation of Day and Shrivastava[21].

Acknowledgements

The authors are grateful to the Head, Department of Life

Table 1. Effect of Cu, Mn and TM application (Treatments) on T-chl content of *Zingiber officinale* Rosc.L. VAR-1 at different stages of days after plantation (DAP).

Treatments	Levels of total chlorophyll (mg/g)			
	90 DAP	120 DAP	150 DAP	180 DAP
T_1	0.357±0.048	0.203±0.005	0.249±0.003	0.358±0.002
T_2	0.499±0.036	0.232±0.025	0.312±0.008	0.428±0.004
T_3	0.454±0.028	0.259±0.002	0.273±0.093	0.371±0.006
T_4	0.418±0.095	0.311±0.008	0.254±0.006	0.470±0.006
T_5	0.519±0.023	0.245±0.013	0.316±0.002	0.403±0.026
T_6	0.673±0.000	0.263±0.018	0.346±0.000	0.309±0.031
CD at 5%	0.042	0.022	0.020	0.016
CD at 1%	0.076	0.037	0.033	0.026

Table 2. Effect of Cu, Mn and TM application on Chl - a content of *Zingiber officinale* Rosc. L. VAR-1 at different stages of days after plantation (DAP).

Treatments	Levels of chlorophyll a (mg/g)			
	90 DAP	120 DAP	150 DAP	180 DAP
T_1	0.120±0.007	0.117±0.003	0.143±0.003	0.178±0.015
T_2	0.142±0.016	0.133±0.001	0.169±0.006	0.265±0.012
T_3	0.149±0.005	0.139±0.008	0.144±0.008	0.209±0.018
T_4	0.166±0.022	0.183±0.006	0.159±0.008	0.284±0.005
T_5	0.137±0.011	0.131±0.013	0.179±0.001	0.225±0.024
T_6	0.154±0.002	0.151±0.005	0.206±0.004	0.188±0.005
CD at 5 %	0.010	0.006	0.004	0.014
CD at 1 %	0.016	0.010	0.006	0.023

Table 3. Effect of Cu , Mn and TM application on Chl - b content of *Zingiber officinale* Rosc. L. VAR-1 at different stages of days after plantation (DAP).

Treatments	Levels of chlorophyll b (mg/g)			
	90 DAP	120 DAP	150 DAP	180 DAP
T_1	0.192±0.021	0.085±0.002	0.132±0.017	0.095±0.011
T_2	0.358±0.020	0.170±0.001	0.165±0.017	0.142±0.003
T_3	0.311±0.002	0.117±0.004	0.162±0.007	0.086±0.003
T_4	0.369±0.000	0.128±0.002	0.182±0.005	0.107±0.008
T_5	0.369±0.028	0.105±0.009	0.179±0.002	0.137±0.002
T_6	0.526±0.003	0.112±0.013	0.164±0.011	0.139±0.003
CD at 5 %	0.012	0.004	0.010	0.008
CD at 1 %	0.020	0.006	0.016	0.013

Table 4. Effect of Cu, Mn and TM application on Carotenoid (Ca) content of *Zingiber officinale* Rosc. L.VAR-1 at different stages of days after plantation(DAP).

Treatments	Levels of carotenoid (mg/g)			
	90 DAP	120 DAP	150 DAP	180 DAP
T_1	0.884±0.012	1.333±0.026	0.971±0.023	2.088±0.302
T_2	0.999±0.018	1.517± 0.051	1.256±0.062	2.543±0.092
T_3	1.074 ±0.015	1.582±0.062	0.912±0.023	2.376±0.128
T_4	2.036±0.214	1.990±0.104	1.131±0.010	2.886±0.015
T_5	1.061±0.068	1.575±0.147	1.032 ±0.019	2.684±0.143
T_6	1.858±0.025	1.964±0.116	1.493±0.025	1.956±0.174
CD at 5%	0.066	0.096	0.030	0.163
CD at 1%	0.111	0.161	0.050	0.272

Sciences, Manipur University, Canchipur, Imphal, for laboratory facilities.

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