CHAPTER III

STUDIES ON THE EFFECT OF GRADED LEVELS OF EDTA AND DTPA ON YIELD AND COMPOSITION OF BARLEY AND PADDY PLANTS RAISED IN SAND CULTURE:

EXPERIMENTAL RESULTS

Experiment No. 1
Effect of graded levels of EDTA on yield, ascorbic acid and chlorophyll content, catalase activity and tissue nitrate, calcium, potassium, magnesium, phosphorus, sulphur, nitrogen, iron and manganese of barley (Hordeum vulgare L. var. Jyoti) plants raised in sand culture

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Experiment No. 2

Effect of graded levels of EDTA on yield, ascorbic acid and chlorophyll content, catalase activity and tissue nitrate, calcium, potassium, magnesium, phosphorus, sulphur, nitrogen, iron and manganese of paddy \(\text{(Oryza sativa L. var. Sona)}\) plants raised in sand culture:

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Experiment No. 3

Effect of graded levels of DTPA on yield, ascorbic acid and chlorophyll content, catalase activity and tissue nitrate, calcium, potassium, magnesium, phosphorus, sulphur, nitrogen, iron and manganese of barley \(\text{(Hordeum vulgare L. var. Jyoti)}\) plants raised in sand culture:

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Effect of graded levels of DTPA on yield, ascorbic acid and chlorophyll content and catalase activity and tissue nitrate, calcium, potassium, magnesium, phosphorus, sulphur, nitrogen, iron and manganese of paddy (Oryza sativa L. var. Sona) plants raised in sand culture.

**SUMMARY**

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**Experiment No. 4**

Effect of graded levels of DTPA on yield, ascorbic acid and chlorophyll content and catalase activity and tissue nitrate, calcium, potassium, magnesium, phosphorus, sulphur, nitrogen, iron and manganese of paddy (Oryza sativa L. var. Sona) plants raised in sand culture:

Dry matter yield

Ascorbic acid

Chlorophyll

Catalase activity

Nitrate

Calcium

Potassium

Magnesium

Phosphorus

Sulphur

Nitrogen

Iron

Manganese

SUMMARY

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CHAPTER III

STUDIES ON THE EFFECT OF GRADED LEVELS OF EDTA AND DTPA ON YIELD AND COMPOSITION OF BARLEY AND PADDY PLANTS RAISED IN SAND CULTURE

Chelates are known to influence plant growth, metabolism and mineral uptake, however all authors are not in agreement about their beneficial of toxic levels of application. The experiments presented in this chapter were performed with a view to re-examine some of the earlier findings and to investigate the influence of EDTA and DTPA on growth, certain metabolites and mineral composition of barley and paddy.

EXPERIMENTAL

In order to achieve above mentioned aims and object four experiments described in this chapter were performed. With a view to provide sufficiently pure and uniform culture medium experimental plants of barley and paddy were raised in thrice cold acid washed white silica sand under sand culture conditions in their respective growing seasons. Material and methods and composition of diluted nutrient solution has already been described in Chapter II. The different levels of EDTA and
DTPA (nil, 6.25, 25, 100 and 400 ppm) were supplied daily to respective pots along with full nutrient solution.

Plant samples were drawn and estimations were made for:

(i) dry matter yield of barley and paddy tops at 30 and 90 days growth and grains of 120 days old plants;

(ii) ascorbic acid content of barley and paddy tops at 30 and 90 days growth;

(iii) chlorophyll content in leaves of 30 and 90 days old barley and paddy plants;

(iv) catalase activity of barley and paddy tops at 30 and 90 days growth;

(v) tissue concentration of nitrate of barley and paddy tops at 30 and 90 days growth and barley grains of 120 days old plants; and

(vi) tissue concentration of calcium, potassium, magnesium, phosphorus, sulphur, nitrogen, iron and manganese of barley and paddy tops at 30 and 90 days growth and grains of 120 days old plants.
RESULTS

Experiment No. 1:

Effect of graded levels of EDTA on yield, ascorbic acid and chlorophyll content, catalase activity and tissue nitrate, calcium, potassium, magnesium, phosphorus, sulphur, nitrogen, iron and manganese of barley (Hordeum vulgare L.var. Jyoti) plants raised in sand culture:

Dry matter yield (fig. 1): In 30 days old barley plant tops with 400 ppm level of EDTA supply a highly significant (P=0.01) decrease in yield over control was observed, other differences failed to reach the level of significance. At 90 days old tops over control a highly significant (P=0.01) increase in yield was found at 6.25 ppm level beyond which the yield showed a decreasing trend. In grains 25 ppm level brought a highly significant (P=0.01) increase in yield over that at control and beyond 25 ppm a significant (P=0.05) decrease was observed. About 80% increase in yield of grains over control was found when 25 ppm EDTA was supplied and about 60% increase when 100 ppm EDTA was supplied.

Ascorbic acid (fig. 2): With the increase in EDTA level ascorbic acid content of tops at 30 days growth increased significantly (P=0.05) upto 25 ppm. At 90 days growth ascorbic acid content increased up to 100 ppm level of EDTA supply significantly (P=0.01) beyond which a highly significant (P=0.01) decrease was observed at 400 ppm level. Highest values of ascorbic acid content were found at 6.25 ppm level in tops at 30 days growth and at 100 ppm level in tops at 90 days growth showing an increase of about 16% over control.
EFFECT OF EDTA ON DRY MATTER YIELD OF BARLEY (HORDEUM VULGARE L. VAR. JYOTI) PLANTS

Fig. 1

DROUGHT TOLERANCE OF MAIZE (ZEA MAYS L.) PLANTS
Effect of EDTA on Ascorbic Acid, Chlorophyll, Catalase, and Nitrate Content of Barley (Hordeum Vulgare, L. var. Jyoti) Plants

![Graphs showing the effect of EDTA on various plant parameters.](image_url)
Chlorophyll (fig. 2): In leaves of 30 days old tops the chlorophyll content was found to increase significantly (P=0.05) up to 100 ppm level of EDTA supply over control. A significant (P=0.05) increase in chlorophyll content was found in leaves of 90 days old plants at 6.25 ppm over control. Further enhancement in the level of EDTA supply decreased chlorophyll content significantly (P=0.05).

Catalase activity (fig. 2): At both the stages of growth in tops EDTA supply increased catalase activity significantly. Maximum catalase activity was found at 25 ppm level. A decrease in EDTA level below 25 ppm and increase above 25 ppm depressed catalase activity significantly (P=0.05). Over control at 25 ppm level at 30 days growth about 40% increase in catalase activity was observed.

Nitrate (fig. 2): In tops at 30 days growth differences in the nitrate content at different levels of EDTA supply failed to reach the level significance. EDTA at 90 days growth in tops brought a highly significant (P=0.01) increase and in grains a highly significant (P=0.01) decrease in tissue nitrate over control. The increase in tissue nitrate of 90 days tops over control was found to be about 34% and decrease in tissue nitrate of grains over control was found to be about 28%.

Calcium (fig. 3): Over control in 30 days tops tissue calcium increased significantly (P=0.05) at 6.25 and 25 ppm levels. At higher levels a decrease in calcium content was observed which was significant (P=0.05) at 400 ppm. In 90 days tops significant (P=0.05) increase in tissue calcium over control was found at 100 ppm level, beyond which a decrease was observed. In grains over control 100 ppm level brought a significant (P=0.05) and 400 ppm a highly significant (P=0.01) decrease in tissue calcium.
EFFECT OF EDTA ON Ca, K, Mg & P CONTENT OF BARLEY (HORDEUM VULGARE, L. VAR. JYOTI) PLANTS

Fig. 3
Potassium (fig. 3): In grains EDTA supply failed to show any significant effect on tissue potassium. In tops at 30 days growth, 25 ppm brought a highly significant (P=0.01) decrease in potassium content. In tops at 90 days growth 6.25 ppm and higher levels brought a significant (P=0.05) increase in tissue potassium over control. The decrease in tissue potassium in 30 days tops and its increase in 90 days tops was found to be about 20%.

Magnesium (fig. 3): Magnesium content in tops at 30 days growth increased significantly (P=0.05) over control when 25 ppm EDTA was supplied. At higher levels it showed a marked decrease. In 90 days tops significant (P=0.05) increase in tissue magnesium over control was found at all the levels of EDTA supply. In grains the effect of EDTA on tissue magnesium failed to show any significant differences.

Phosphorus (fig. 3): In tops at 30 days growth upto 25 ppm, in tops at 90 days growth and in grains at all the levels of EDTA supply a highly significant (P=0.01) increase in phosphorus content over control was found. Over control about 20% increase in tops at both the stages of growth and in grains about 40% increase in phosphorus content was observed.

Sulphur (fig. 4): EDTA supply decrease the sulphur content of barley plant tops over control. In tops at 30 days growth decrease at all the levels of EDTA supply was found to be highly significant (P=0.01). In tops at 90 days growth decrease in tissue sulphur at 100 and 400 ppm levels of EDTA supply was found to be significant (P=0.05). In grains the differences in sulphur content were not found significant. Over control at 30 and 90 days tops the decrease was about 27% and 18% respectively.
EFFECT OF EDTA ON S, N, Fe & Mn CONTENT OF BARLEY (HORDEUM VULGARE, L. VAR. JYOTI) PLANTS

% SULPHUR

% NITROGEN

PPM IRON

PPM MANGANESE

LOG PPM EPTA L.S.D. 5% 1%

LOG PPM EDTA L.S.D. 5% 1%

- - - 30 DAYS (TOPS) - - - 90 DAYS (TOPS) - - - 120 DAYS (GRAINS)

Fig. 4
Nitrogen (fig. 4): At 30 days tops tissue nitrogen was not affected significantly by EDTA supply. At 90 days growth in tops and in grains EDTA brought highly significant (P=0.01) decrease in tissue nitrogen over control. At 25 ppm level and beyond in tops and at 100 ppm level and beyond in grains a decrease in nitrogen content was found to be about 12% over control.

Iron (fig. 4): 25 ppm EDTA level in tops at 30 days growth and 6.25 ppm and higher levels in tops at 90 days growth brought a highly significant (P=0.01) increase in iron content over control. In grains EDTA supply failed to bring any significant change in the tissue iron. Highest values of tissue iron were found at 25 ppm level in 30 days tops and at 100 ppm level in 90 days tops. The increase in tissue iron over control was found to be about 23% in tops at 30 days growth and about 34% in tops at 90 days growth.

Manganese (fig. 4): Over control a significant (P=0.05) increase in tissue manganese at 6.25, 25 and 100 ppm levels of EDTA supply in tops at 30 days growth and a highly significant (P=0.01) increase in tissue manganese at 6.25 ppm level in grains was observed. As compared to control in tops at 90 days growth tissue manganese decreased significantly (P=0.05) at 6.25 ppm level and highly significantly (P=0.01) at 25 ppm level. The decrease in tops at 90 days growth was found to be about 24% increase in 30 days tops about 29% and in grains about 38%. Highest values of tissue manganese in grains and in tops at 30 days growth were found at 25 ppm level. In tops at 90 days growth control showed the highest values which were almost equal to those at 100 ppm level.
Experiment No. 2:

Effect of graded levels of EDTA on yield, ascorbic acid and chlorophyll content, catalase activity and tissue nitrate, calcium, potassium, magnesium, phosphorus, sulphur, nitrogen, iron and manganese of paddy (Oryza sativa L. var. Sona) plants raised in sand culture:

Dry matter yield (fig. 5): Dry matter yield of plant tops at 30 days and 90 days growth at 25 ppm EDTA level and of grains at 6.25 and 25 ppm levels showed a significant (P=0.05) increase over control. At 100 ppm level dry matter yield of tops at both the stages of growth showed a highly significant (P=0.01) decrease and of grains a significant (P=0.05) decrease as compared to control. The yield of 30 days old tops at 400 ppm level also showed a highly significant (P=0.01) decrease. At 400 ppm level paddy plants failed to survive after one month. In tops as well as in grains, the decrease in yield at 100 ppm level as compared to that at 25 ppm level was found to be highly significant (P=0.01) . Highest values were found at 25 ppm level showing about 15% to 20% increase in tops and about 70% increase in grains over control.

Ascorbic acid (fig. 6): At 6.25 ppm and 25 ppm levels in tops at 30 days growth and 6.25 and 100 ppm levels in tops at 90 days growth, ascorbic acid content showed a highly significant (P=0.01) increase over control. The increase in ascorbic acid content of 90 days old tops at 25 ppm level over that at 6.25 ppm and at 100 ppm level over that at 25 ppm and of 30 days tops a decrease in ascorbic acid content at 100 ppm level over that at 25 ppm was found to be significant (P=0.05). The decrease in ascorbic acid content of 30 days tops at 400 ppm level over that at 100 ppm was found to be highly significant (P=0.01). At 25 ppm in 30 days old tops and 100 ppm in 90 days old tops about 10% increase in ascorbic acid content over control was observed.
EFFECT OF EDTA ON DRY MATTER YIELD OF PADDY (ORYZA SATIVA, L. VAR. SONA) PLANTS

Fig. 5
EFFECT OF EDTA ON ASCORBIC ACID, CHLOROPHYLL, CATALASE & NITRATE CONTENT OF PADDY (ORYZA SATIVA, L. VAR. SONA) PLANTS

- **Ascorbic Acid**: 150 mg/100 g Fw
- **Chlorophyll**: 200 mg/100 g Fw
- **Units Catalase**: 15 units/g Fw
- **Nitrate**: 0.10%

Graphs showing changes over 30 and 90 days (tops) with EDTA treatments. L.S.D. values indicated.
Chlorophyll (fig. 6): EDTA increased chlorophyll content at both the stages of growth. Highest values of chlorophyll were found at 25 ppm level in 90 days old plants. At 30 days growth all treatment levels increased chlorophyll content significantly (P=0.01). In leaves of 30 days plants a highly significant (P=0.01) increase in chlorophyll content at 25 ppm over 6.25 ppm, a highly significant (P=0.01) decrease in tissue chlorophyll at 100 ppm as compared to 25 ppm and at 400 as compared to that at 100 ppm EDTA level was observed. At 90 days growth all the treatment levels increased chlorophyll content significantly (P=0.01) over control.

Catalase activity (fig. 6): EDTA increased catalase activity in paddy plant tops at both the stages of growth. Highest values for catalase activity were recorded at 100 ppm level in 30 days old tops and at 25 ppm level in 90 days old tops. At 30 days growth each level of EDTA upto 100 ppm enhanced catalase activity significantly (P=0.01) over control. At 400 ppm level this enhancement was found to be significant (P=0.05). At 25 ppm over 6.25 ppm level a significant (P=0.05) increase in catalase activity was recorded. Decrease in catalase activity became highly significant (P=0.01) at 400 ppm over 100 ppm level. At 90 days growth all the three treatment levels increased catalase activity significantly (P=0.01) over control. At 25 ppm over 6.25 ppm level the increase in catalase activity was found to be highly significant (P=0.01) and at 100 ppm over 25 ppm level it's decrease was found to be highly significant (P=0.01). At 25 ppm level about 45% increase in catalase activity over control was observed.
Nitrate (fig. 6): Nitrate content showed highly significant (P=0.01) increase only at 6.25 ppm level. Higher levels brought a decrease in nitrate content. In 30 days tops as compared to control 6.25 ppm level increased nitrate content significantly (P=0.01) while 25 and 100 ppm levels decreased the same significantly (P=0.01). The decrease in nitrate content at 25 ppm over 6.25 ppm level and increase at 400 ppm level over 100 ppm level was found to be highly significant (P=0.01). In 90 days old tops only 6.25 ppm level increased tissue nitrate significantly (P=0.01) over control. At 25 ppm level decrease in tissue nitrate over 6.25 ppm level was significant (P=0.05). In 30 days tops about 13% and 90 days tops about 40% increase in tissue nitrate was found at 6.25 ppm level as compared to control.

Calcium (fig. 7): The EDTA supply decreased tissue calcium in 30 days tops but increased the same in grains. Over control the decrease in calcium content at 25 and 100 ppm levels in 30 days tops and increase in tissue calcium at 25 ppm level in grains was found to be significant (P=0.05). Decrease in tissue calcium at 400 ppm level in 30 days tops and increase at 6.25 ppm level in grains was found to be highly significant (P=0.01). The increase in calcium content of grains at 25 ppm level as compared to that at 6.25 ppm level was significant (P=0.05). Other differences failed to reach the level of significance. In grains an increase in tissue calcium of about 50% at 6.25 ppm level and of about 25% at 25 ppm level over control was observed.

Potassium (fig. 7): As compared to control in 30 days tops potassium content decreased at 100 ppm level significantly (P=0.05) and at 400 ppm level highly significantly (P=0.01). In 90 days old tops the increase in potassium content at 6.25 ppm level was found to be highly
EFFECT OF EDTA ON Ca, K, Mg & P CONTENT OF PADDY (ORYZA SATIVA, L. VAR. SONA) PLANTS

Fig. 7
significant \( (P=0.01) \) and at 100 ppm level significant \( (P=0.05) \) over control. Decrease in potassium content at 25 ppm level over 6.25 ppm level was found to be significant \( (P=0.05) \). Potassium content of grains failed to show any significant differences in response to EDTA supply. In 90 days tops increase in tissue potassium as compared to control was found to be about 28%.

Magnesium (fig. 7): In 30 days old tops at 6.25, 25 and 100 ppm levels and in grains at 100 ppm level an increase in magnesium content over control was found to be highly significant \( (P=0.01) \). At 400 ppm in 30 days tops, at 25 ppm in 90 days tops and at 25 ppm in grains the increase in magnesium content was found to be significant \( (P=0.05) \). As compared to 100 ppm level tissue magnesium at 400 ppm in 30 days tops showed a significant \( (P=0.05) \) decrease. Highest values of magnesium content were found at 25 ppm level. These values showed about 23% increase in 30 days tops, about 11% increase in 90 days tops and about 30% increase in grains.

Phosphorus (fig. 7): An overall significant \( (P=0.01) \) increase in phosphorus content was recorded in treated plants. Significantly \( (P=0.05) \) higher tissue phosphorus at 25 ppm over 6.25 ppm in 30 days tops and grains was observed. Increase in phosphorus content at 25 ppm over 6.25 ppm level in 90 days tops and at 100 ppm over 25 ppm level in grains was found to be highly significant \( (P=0.01) \). Highest values of tissue phosphorus were found at 6.25 ppm level showing about 60% increase in 30 days tops, 47% increase in 90 days tops and 80% increase in grains over control.

Sulphur (fig. 8) EDTA decreased sulphur content in plant tops but increased the same in grains. Except at 6.25 ppm level in 90 days tops in grains where the differences in sulphur content as compared to that...
Effect of EDTA on S, N, Fe & Mn Content of Paddy (Oryza Sativa, L. var. Sona) Plants

Fig. 8
of control failed to reach the level of significance and at 25 ppm level where decrease in sulphur content as compared to control was found to be significant (P=0.05), all other differences at different levels of EDTA at different stages of growth, were found to be highly significant (P=0.01). Decrease in tissue sulphur in 90 days tops at 100 ppm level as compared to 25 ppm level and increase in tissue sulphur of grains at 25 ppm over 6.25 ppm level was found to be highly significant (P=0.01). Increase in grains at 100 ppm over 25 ppm level was found to be significant (P=0.05). Grains at 25 ppm level showed about 50% increase in tissue sulphur.

Nitrogen (fig. 8): Between tissue nitrogen and the levels of EDTA supply upto 25 ppm a direct relationship was foundin 30 days tops while an inverse relationship was recorded in 90 days old tops. In 30 days tops 25 ppm level increased tissue nitrogen significantly (P=0.05) over control. In tops at 90 days growth decrease in nitrogen content was found to be significant (P=0.05), at 6.25 ppm level and a highly significant (P=0.01) at 25 ppm level over control. Decrease in tissue nitrogen was found to be highly significant (P=0.01 at 25 ppm level over 6.25 ppm level and at 100 ppm level over 25 ppm level. In grains only 6.25 ppm level showed significant (P=0.05) increase in nitrogen content over control. A highly significant (P=0.01) decrease in nitrogen content at 25 ppm over that at 6.25 ppm level was also observed. Other differences were not found significant

Iron (fig. 8): EDTA supply brought an over all highly significant (P=0.01) increase in tissue iron. In 30 days tops at 400 ppm, in 90 days tops at 25 ppm and in grains at 6.25 ppm highest values of tissue iron were found. The increase in tissue iron at 400 ppm over 25 and 100 ppm levels in 30 days tops, decrease in tissue iron at
100 ppm over 25 ppm in 90 days tops and at 25 ppm over 6.25 ppm in grains was found to be highly significant (P=0.01). EDTA increased the iron content of plants over control to the extent of about 50% to 60%.

**Manganese (fig. 8):** In 30 days paddy tops at 25 ppm and 100 ppm EDTA levels a significant (P=0.05) increase in tissue manganese over that at control was observed. In grains at 25 ppm EDTA level over control a highly significant (P=0.01) increase in tissue manganese was observed. In grains at 25 ppm level the increase in manganese content over that at 6.25 ppm level and 100 ppm level was found to be highly significant (P=0.01). At 25 ppm level grains showed about 100% increase in tissue manganese over control.
Experiment No. 3

Effect of graded levels of DTPA on yield, ascorbic acid and chlorophyll content, catalase activity and tissue nitrate, calcium potassium, magnesium, phosphorus, sulphur, nitrogen, iron and manganese of barley (Hordeum vulgare L. var. Jyoti) plants raised in sand culture.

Dry matter yield (fig. 9): Over all DTPA up to 25 ppm level significantly increased yield and further enhancement in DTPA level brought a decrease in yield. At 90 days growth in barley tops and grains 6.25 ppm level increased dry matter yield remarkably. At 25 ppm level in tops and 6.25 ppm 25 ppm levels in grains the increase in yield was found to be highly significant ($P=0.01$) and at 6.25 ppm in 90 days tops significant ($P=0.05$) over control. Increase in yield was found more marked at 25 ppm level as compared to 6.25 ppm level. As compared to control in 30 days tops at 100 and 400 ppm levels a significant ($P=0.05$) and highly significant ($P=0.01$) decrease in yield was observed respectively. At 400 ppm level in 90 days tops and in grains a highly significant ($P=0.01$) decrease in yield over control was observed. The differences in yield between 25 ppm and 100 ppm, between 100 ppm and 400 ppm in 30 days tops, between 100 ppm and 400 ppm in 90 days tops and grains were found to be significant ($P=0.05$). At 25 ppm level (which showed highest values of yield) about 10% increase in tops at 30 days growth, about 20% increase in tops at 90 days growth and about 60% increase in grains was observed over control.

Ascorbic acid (fig. 10): Over control significant ($P=0.05$) increase in ascorbic acid content in 30 days tops with 25 ppm level and highly significant ($P=0.01$) increase in ascorbic acid content in 90 days tops with 100 ppm level of DTPA supply was found. Over control 100 ppm and 400 ppm levels decreased ascorbic acid content highly significantly ($P=0.01$)
EFFECT OF DTPA ON DRY MATTER YIELD OF BARLEY
(HORDEUM VULGARE, L. VAR. JYOTI) PLANTS

Fig. 9
EFFECT OF DTPA ON ASCORBIC ACID, CHLOROPHYLL, CATALASE & NITRATE CONTENT OF BARLEY (HORDEUM VULGARE, L. VAR. JYOTI) PLANTS

Fig. 10
**Chlorophyll (fig. 10):** Although in leaves of 30 days old barley plants a significant (P=0.05) increase in chlorophyll content over control was observed at 100 ppm level only. In leaves of 90 days old plants all the four 6.25, 25, 100 and 400 ppm levels brought a highly significant (P=0.01) increase in chlorophyll content over control. As compared to 100 ppm at 400 ppm level chlorophyll content showed a highly significant (P=0.01) decrease at 90 days growth. 25 ppm level brought about 60% increase in the chlorophyll content of 90 days plants over control.

**Catalase activity (fig. 10):** Except 400 ppm level in tops at 90 days growth all other levels of DTPA supply at both the stages of growth brought a highly significant (P=0.01) increase in catalase activity over control. Increase in catalase activity at 25 ppm over 6.25 ppm and decrease in catalase activity at 100 ppm over 25 ppm in 30 days tops and decrease in catalase activity at 400 ppm over 100 ppm in 90 days tops was found to be highly significant (P=0.01). Highest values of catalase activity were observed at 25 ppm level in tops at both the stages of growth showing about 70% increase in tops at 30 days growth and about 23% increase in tops at 90 days growth over control.

**Nitrate (fig. 10):** In 30 days tops and grains 25 ppm level brought a significant (P=0.05) decrease in nitrate content over control. At 400 ppm in 30 days tops and at 100 and 400 ppm in grains decrease in nitrate content was found to be highly significant (P=0.01). Decrease in tissue nitrate at 400 ppm over 100 ppm level in 30 days tops and at 100 ppm over 25 ppm level in grains was found to be highly significant (P=0.01). In tops at 90 days growth 25 ppm and 100 ppm levels brought a significant (P=0.05) and at 400 ppm level a highly
significant (P=0.01) increase in nitrate content over control.

**Calcium** (fig. 11): Calcium content of plants over control increased significantly (P=0.05) at 25 and 400 ppm levels and highly significant (P=0.01) at 100 ppm level in 30 days tops. Highest values of calcium content were found at 100 ppm which were significantly (P=0.05) more than that at 25 ppm and highly significantly (P=0.01) more than that at 400 ppm level. Increase at 100 ppm level was found about 15%.

At 90 days growth in tops calcium content showed highly significant (P=0.01) decrease over control and significant (P=0.05) decrease over that at 100 ppm level. Other differences failed to reach the level of significance.

**Potassium** (fig. 11): Over control potassium content at 25 ppm level in 30 days tops and 25 and 100 ppm levels in 90 days tops showed a highly significant (P=0.01) increase. At 100 ppm level in 30 days tops only a significant (P=0.05) increase in tissue potassium was observed. At 100 ppm level in 90 days tops a highly significant (P=0.01) decrease in tissue potassium over control was found. The increase in potassium content at 25 ppm level over that at 6.25 ppm level in 30 days tops was found to be significant (P=0.05) and at 25 ppm level over that at 6.25 ppm and at 100 ppm level over that at 25 ppm level in 90 days tops was found to be highly significant (P=0.01). The decrease in tissue potassium at 400 ppm over 100 ppm in tops at both stages of growth was found to be highly significant (P=0.01). The differences in tissue potassium of grains in response to DTPA supply failed to reach the level of significance. Highest values of tissue potassium were found at 25 ppm level in tops at 30 days growth and at 100 ppm level in tops at 90 days growth, the increase over control in tissue potassium in former case being
EFFECT OF DTPA ON Ca, K, Mg & P CONTENT OF BARLEY (HORDEUM VULGARE, L. VAR. JYOTI) PLANTS

**Calcium**

- Log PPM
- DTPA
- L.S.D.

**Potassium**

- Log PPM
- DTPA
- L.S.D.

**Magnesium**

- Log PPM
- DTPA
- L.S.D.

**Phosphorus**

- Log PPM
- DTPA
- L.S.D.

- 30 DAYS (TOPS)
- 90 DAYS (TOPS)
- 120 DAYS (GRAINS)
about 20% and in later case about 30%.

**Magnesium (fig. 11):** In tops at both the stages of growth highest values of tissue magnesium were found at 6.25 ppm level. Over control at 6.25 ppm level in 30 days tops and at 6.25 and 25 ppm levels in 90 days tops the increase in magnesium content was found to be highly significant ($P=0.01$). At 100 ppm level in 90 days tops a significant ($P=0.05$) increase was observed. 400 ppm level brought a significant ($P=0.05$) decrease in tissue magnesium over that at 100 ppm in 90 days tops. In 30 days tops at 25 ppm as compared to that at 6.25 ppm a significant ($P=0.05$) decrease in magnesium content was found. Other differences in the magnesium content in response to DTPA either in tops or in grains failed to reach the level of significance. Increase in tissue magnesium in response to DTPA supply was found to be about 20% to 30%.

**Phosphorus (fig. 11):** DTPA increased phosphorus content in tops but in grains no significant differences were found. In tops at both the stages of growth over control a highly significant ($P=0.01$) increase in phosphorus content at 25 ppm over that at 6.25 ppm level and significant ($P=0.05$) decrease in the same at 400 ppm as compared to that at 100 ppm level was observed. At 25 ppm level about 40% increase in tissue phosphorus over control was observed, which was found to be more obvious in tops at 90 days growth.

**Sulphur (fig. 12):** At 30 days growth in tops DTPA did not show any significant differences in tissue sulphur but in 90 days tops and grains 6.25, 100 and 400 ppm levels brought a highly significant ($P=0.01$) decrease and at 25 ppm a significant ($P=0.05$) decrease in sulphur content as compared to control. In grains at 400 ppm the
EFFECT OF DTPA ON S, N, Fe & Mn CONTENT OF BARLEY (HORDEUM VULGARE, L. VAR. JYOTI) PLANTS

**% SULPHUR**

- 0.75%
- 0.60%
- 0.45%
- 0.30%
- 0.15%

**% NITROGEN**

- 5.0%
- 4.0%
- 3.0%
- 2.0%
- 1.0%

**PPM IRON**

- 500 PPM
- 400 PPM
- 300 PPM
- 200 PPM
- 100 PPM

**PPM MANGANESE**

- 30 PPM
- 25 PPM
- 20 PPM
- 15 PPM

**LOG PPM**

1  2  3  5%  1%

**DTPA**

**L.S.D.**

30 DAYS (TOPS)  90 DAYS (TOPS)  120 DAYS (GRAINS)

Fig. 12
decrease in tissue sulphur as compared to that at 100 ppm level was found to be significant (P=0.05). Over control maximum significant decrease was observed at 400 ppm level and minimum at 25 ppm level.

**Nitrogen** (fig. 12): Although in 30 days tops and grains significant differences in tissue nitrogen in response to DTPA supply were not observed. At 90 days growth in tops all the levels (6.25, 25, 100 and 400 ppm) brought a highly significant (P=0.01) decrease in tissue nitrogen over control.

**Iron** (fig. 12): Over all at all the stages of growth and in both the plants parts DTPA brought a highly significant (P=0.01) increase in tissue iron. Highest values of iron content were found at 25 ppm level. Increase in tissue iron at 25 ppm level over that at 6.25 ppm level and decrease in tissue iron at 100 ppm level as compared to that at 25 ppm level in 30 days tops and at 400 ppm level as compared to that at 100 ppm level in 90 days tops found to be highly significant (P=0.01). Increase in tissue iron at 25 ppm level over that at 6.25 ppm level, and decrease in tissue iron at 100 ppm level as compared to that at 25 ppm level in 30 days tops and at 400 ppm level as compared to that at 100 ppm level in 90 days tops was found to be highly significant (P=0.01). Increase in tissue iron at 25 ppm level over 6.25 ppm level and decrease at 100 ppm level as compared to that at 25 ppm level was found to be significant (P=0.05). At 25 ppm level about 50% increase in tissue iron in tops and about 60% increase in tissue iron in grains was observed over control.
Manganese (fig. 12): In 30 days tops highly significant (P=0.01) decrease in tissue manganese was found at 25, 100 and 400 ppm levels over control. In 90 days tops and grains manganese content showed a highly significant (P=0.05) increase at 6.25 and 25 ppm levels over control. In 90 days tops and grains 100 ppm level showed a highly significant (P=0.05) decrease in tissue manganese as compared to that at 25 ppm level. Except in 30 days tops manganese content showed about 50% increase at 25 ppm level over control.
Experiment No. 4

**Effect of graded levels of DTPA on yield, ascorbic acid and chlorophyll content, catalase activity and tissue nitrate, calcium, potassium, magnesium, phosphorus, sulphur, nitrogen, iron and manganese of paddy (Oryza sativa L. var. Sona) plants raised in sand culture:**

**Dry matter yield (fig. 13):** At 30 days growth in paddy tops 6.25 ppm brought a highly significant (P=0.01) increase in dry matter yield but beyond this level a highly significant (P=0.01) decrease in yield was observed with every increase in the level of DTPA supply. As compared to control at 400 ppm reduction in yield was almost half. Over control increase in yield of 90 days tops at 25 ppm and in grains at 6.25 and 25 ppm levels was significant (P=0.05). At 100 ppm level yield of 90 days tops and grains decreased significantly (P=0.01) as compared to control. Upto 90 days growth at 400 ppm level plants even failed to survive. In grains 6.25 ppm level showed highest yield increasing upto 40% over control.

**Ascorbic acid (fig. 14):** Over all DTPA brought a highly significant (P=0.01) increase in ascorbic acid content of plants. The decrease in ascorbic acid content in 30 days tops at 100 ppm over 25 ppm, at 400 ppm over 100 ppm in 90 days tops, at 100 ppm over 25 ppm and an increase in 90 days tops at 25 ppm over 6.25 ppm was found to be highly significant (P=0.01). Highest values of ascorbic acid content were found at 25 ppm of DTPA supply level showing an increase of about 22% over control.

**Chlorophyll (fig. 14):** Over control in leaves of both 30 and 90 days plants up to 100 ppm level a highly significant (P=0.01) increase in tissue chlorophyll was found with every increase in the level of EDTA
EFFECT OF DTPA ON DRY MATTER YIELD OF PADDY (ORYZA SATIVA, L. VAR. SONA) PLANTS

Fig. 13
Effect of DTPA on Ascorbic Acid, Chlorophyll, Catalase and Nitrate Content of Paddy (Oryza Sativa, L. var. Sona) Plants

![Graphs showing the effect of DTPA on different plant parameters.](image)
supply. In leaves of 30 days plants chlorophyll content at 100 ppm over 25 ppm and at 400 ppm over 100 ppm showed a highly significant (P=0.01) decrease. The increase in tissue chlorophyll at 25 ppm over that at 6.25 ppm was found to be significant (P=0.05). In 90 days plants chlorophyll content at 25 ppm over 6.25 ppm and at 100 ppm over that at 25 ppm showed a significant (P=0.05) decrease. Highest values of chlorophyll content were found at 25 ppm in leaves of 30 days old plants and at 6.25 ppm in 90 days old plants. These values showed about 30% increase in tissue chlorophyll over control.

Catalase activity (fig. 14): DTPA brought a marked increase in catalase activity of plant tops. Over control the increase at 6.25, 25 and 100 ppm levels in 30 days tops and at 6.25 and 25 ppm levels in 90 days tops was found to be highly significant (P=0.01). At 400 ppm level a significant (P=0.05) increase in catalase activity over that at control was observed. Catalase activity at 25 ppm level as compared to that at 6.25 ppm level showed a significant (P=0.05) increase in 30 days tops. At 100 ppm as compared to that at 25 ppm level in 90 days tops the catalase activity showed a highly significant (P=0.01) decrease. At 100 ppm level in 30 days tops and at 25 ppm level in 90 days tops about 50% increase in catalase activity was observed over control.

Nitrate (fig. 14): In 30 days tops over control the tissue nitrate at 6.25 ppm level showed highly significant (P=0.01) and at 25 ppm level a significant (P=0.05) decrease. At 100 ppm a highly significant (P=0.01) increase in nitrate content as compared to that at 25 ppm level was observed. In 90 days tops over control at 6.25 ppm and 25 ppm levels showed a highly significant (P=0.01) and 100 ppm level
a significant \((P=0.05)\) increase in tissue nitrate. 25 ppm brought about 25% decrease in 30 days tops and about 50% increase in 90 days tops over control.

**Calcium** (fig. 15): 6.25 ppm level in 30 days tops brought a significant \((P=0.05)\) increase in calcium content. A highly significant \((P=0.01)\) decrease in calcium content at 400 ppm in 30 days tops and at 100 ppm in grains was observed. In 90 days tops 100 ppm level brought a significant \((P=0.05)\) decrease in calcium content over that at 25 ppm level. Other differences were not found to be significant.

**Potassium** (fig. 15): DTPA decreased tissue potassium in 30 days tops and increased in 90 days tops significantly. In grains significant differences were not found. A highly significant \((P=0.01)\) decrease at 6.25 ppm in 30 days tops and highly significant \((P=0.01)\) increase in potassium content in 90 days tops at 6.25 ppm over control was observed. In 30 days tops highly significant \((P=0.01)\) increase in tissue potassium at 25 ppm level over that at 6.25 ppm and significant \((P=0.05)\) increase at 400 ppm level over that at 100 ppm was found. Significant \((P=0.05)\) increase in tissue potassium at 25 and 100 ppm levels over control in 90 days tops was observed.

**Magnesium** (fig. 15): In 30 days tops tissue magnesium at 6.25 ppm level over control showed a significant \((P=0.05)\) increase and at 25 ppm level as compared to that at 6.25 ppm level showed a significant \((P=0.05)\) decrease. The increase in tissue magnesium over control was found to be highly significant \((P=0.01)\) in 90 days tops at 25 ppm level, in grains at 100 ppm level and in 30 days tops at 6.25 ppm and 25 ppm levels.
EFFECT OF DTPA ON Ca, K, Mg & P CONTENT OF PADDY (ORYZA SATIVA, L. VAR. SONA) PLANTS

CALCIUM

POTASSIUM

MAGNESIUM

PHOSPHORUS

LOG PPM DTPA L. S. D.

1.0

0.75

0.50

0.25

0.0

1.0

0.8

0.6

0.4

0.2

0.0

30 DAYS (TOPS)

90 DAYS (TOPS)

120 DAYS (GRAINS)

Fig. 15
Phosphorus (fig. 15): Except, in 90 days tops at 25 and 100 ppm levels the increase in phosphorus content at rest of the DTPA levels in both grains and tops was found to be highly significant (P=0.01) over control. At 25 ppm level as compared to that at 6.25 ppm level phosphorus content showed a highly significant (P=0.01) decrease in tops but increase in grains. In 30 days tops a decrease in tissue phosphorus at 400 ppm as compared to that at 100 ppm was found to be significant (P=0.05). 6.25 and 25 ppm levels brought about 30% increase in tissue phosphorus over control.

Sulphur (fig. 16): With the increase in the levels of DTPA supply tissue sulphur in 30 days tops decreased but in 90 days tops and grains the same was found to increase. Over control the decrease in tissue sulphur at 25 and 100 ppm levels in 30 days tops, increase in tissue sulphur at 6.25, 25 and 100 ppm levels both in 90 days tops and grains was found to be highly significant (P=0.01). At 6.25 ppm the increase in tissue sulphur over that at control in 30 days tops was found to be significant (P=0.05). Sulphur content at 25 ppm over that at 6.25 ppm in 30 days tops, at 100 ppm over 25 ppm both in 90 days tops and grains showed a significant (P=0.05) decrease. At 400 ppm level as compared to that at 100 ppm tissue sulphur of 30 days tops showed a highly significant (P=0.01) decrease. At 25 ppm tissue sulphur showed a significant (P=0.05) increase as compared to that at 6.25 ppm level in 90 days tops. At 25 ppm level the increase in tissue sulphur of grains was found to be about 50% and of 90 days tops about 20%.

Nitrogen (fig. 16): In 30 days tops 400 ppm level brought a highly significant (P=0.01) increase in tissue nitrogen over control and a significant (P=0.05) increase in tissue nitrogen over that at 100 ppm. In 90 days tops and grains tissue nitrogen at 6.25 ppm level showed highly significant (P=0.01) and significant(P=0.05) increase respectively.
EFFECT OF DTPA ON S, N, Fe & Mn CONTENT OF PADDY (ORYZA SATIVA, L. VAR. SONA) PLANTS

SULPHUR

NITROGEN

IRON

MANGANESE

LOG PPM DTPA

5% L.S.D.

LOG PPM DTPA

5% L.S.D.

0 1 2 3

0 1 2 3

0 100 200 300

0 25 50 75 100 125

30 DAYS (TOPS) 90 DAYS (TOPS) 120 DAYS (GRAINS)

Fig. 16
In 90 days tops the decrease in tissue nitrogen at 100 ppm level over control, at 25 ppm level over that at 6.25 ppm and at 100 ppm level over that at 25 ppm was found to be highly significant \((P=0.01)\). In grains 25 ppm level brought a significant \((P=0.05)\) decrease in tissue nitrogen as compared to that at 6.25 ppm level.

Iron (fig. 16): Both in tops and grains all the levels of DTPA brought a highly significant \((P=0.01)\) increase in iron content over that at control. As compared to that at 6.25 ppm a significant \((P=0.05)\) increase in tissue iron was observed at 25 ppm level in 90 days tops and grains. In 30 days tops at 25 ppm level as compared to that at 6.25 ppm and in grains at 100 ppm as compared that at 25 ppm level a highly significant \((P=0.01)\) decrease in iron content was found. About 50% increase in tissue iron over control was found at 6.25 ppm level in 30 days tops, at 25 ppm level in 90 days tops and grains.

Manganese (fig. 16): Over control in 30 days tops tissue manganese showed a highly significant \((P=0.01)\) increase with each increase in the level of DTPA supply. In grains a significant \((P=0.05)\) increase in manganese content over that at control was observed at 6.25 and 25 ppm levels. Decrease in tissue manganese at 400 ppm level as compared to that at 100 ppm level in 30 days tops was found to be significant \((P=0.05)\). Decrease in tissue manganese at 100 ppm level as compared to that at 25 ppm level in grains was found to be highly significant \((P=0.01)\). Other differences failed to reach the level of significance. Both in 30 days tops and grains about 30% increase in tissue manganese was found over control at 25 ppm level.
Barley (Hordeum vulgare, L. var. Jyoti) and paddy (Oryza sativa L. var. Sona) plants were raised under sand culture conditions with Nil, 6.25, 25, 100 and 400 ppm levels of EDTA and DTPA along with full nutrient solution. The plants were sampled at 30 and 90 days growth for tops and at 120 days growth for grains. As study of dry matter yield, ascorbic acid, chlorophyll content, catalase activity and tissue nitrate, calcium, potassium, magnesium, phosphorus, sulphur, nitrogen, iron and manganese content of plants reveals following important points:

1. Both in barley and paddy at all the stages of growth studied, both the plant parts whether tops or grains showed an increase in yield with the increase in the levels of EDTA and DTPA up to 25 ppm. Beyond 25 ppm an increase in the level of EDTA and DTPA supply brought a depression in dry matter yield.

2. Maximum yield was found at 25 ppm level. At 25 ppm level of supply EDTA brought an increase in grains yield of about 70% in paddy and about 85% in barley and DTPA brought an increase of about 32% in paddy and about 60% in barley. Both EDTA and DTPA proved toxic at 100 and 400 ppm levels and toxic effects were more pronounced in paddy than in barley.

3. EDTA and DTPA increased ascorbic acid content. Maximum increase was found at 25 ppm level; the effects were more marked in paddy as compared to barley.

4. Though EDTA and DTPA increased chlorophyll content up to 400 ppm level; highest values of chlorophyll content were observed in the range of 6.25 to 25 ppm and paddy showed better responses than barley.

5. EDTA and DTPA increased catalase activity. Maximum catalase
activity was recorded in the range of 6.25 and 25 ppm.

An increase in tissue nitrate in response to EDTA and DTPA supply was observed in 90 days tops only. In grains and 30 days old tops tissues nitrate decreased.

EDTA and DTPA generally decreased nitrogen content of plants more so in barley. The decrease in nitrogen content became more pronounced with the increase in supply levels.

EDTA and DTPA in the range of 6.25 to 25 ppm generally brought an increase in tissue calcium. Higher levels of chelates decreased it.

The responses of tissue potassium to EDTA or DTPA supply were not found generally consistent, though some times an increase was recorded.

EDTA and DTPA increased tissue magnesium both in barley and paddy. Generally highest values of tissue magnesium were found at 25 ppm level.

EDTA and DTPA increased tissue phosphorus markedly. Highest values of tissue phosphorus were found in the range of 6.25 to 25 ppm levels.

Tissue sulphur generally decreased when EDTA and DTPA were supplied.

EDTA and DTPA brought a very marked increase in tissue iron of both barley and paddy. Normally maximum increase in tissue iron was found in the range of 6.25 to 25 ppm levels.

EDTA and DTPA generally increased tissue manganese at lower levels.

DTPA was found better than EDTA for the increase in chlorophyll catalase activity and tissue iron and magnesium in both the crops and phosphorus in barley only.