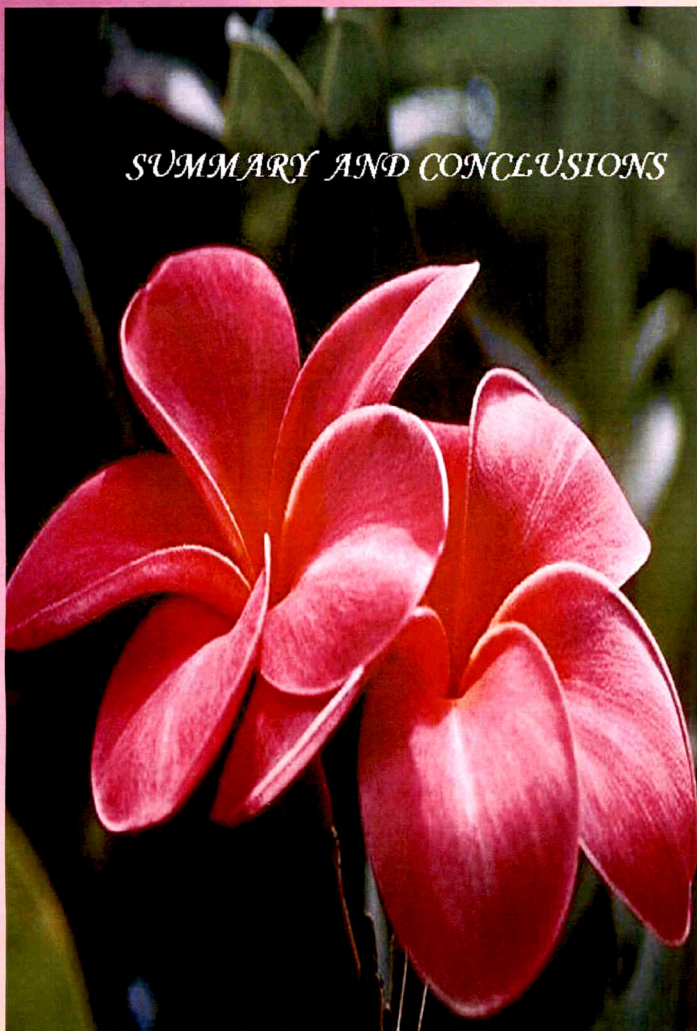


SUMMARY AND CONCLUSIONS



Among different plant groups, grasses perhaps form the most important plant group from the point of view of survival of human race on this planet since all the cereals which provide food grains to human beings belong to this group. Besides food for human beings, the grasses have also provided forage for animals. Apart from this universal role, some grasses have occupied a special position in human culture. Vetiver grass is one such grass. Vetiver grass (*Chrysopogon zizanioides* (L. Roberty)) is a highly important aromatic grass which is cultivated in many parts of the world due to its various applications. The essential oil is an important component which is present in Vetiver roots, therefore the roots are termed as 'scented roots'. This essential oil is used extensively in perfumes, soaps, lotions, ointment etc. Along with such economical use, Vetiver is used to combat soil erosion, to reduce soil pollution created by heavy metals and also used in polluted waste water to reduce pollution. The grass also serves as fodder grass. It is very hardy in nature and can withstand in variable climatic conditions, the spongy root system makes complex with adjacent soil in rhizosphere, and hence it reduces soil erosion. It also has ability to absorb heavy metal pollutants from polluted soil and water therefore, now, days various studies are concentrated on this particular aspect and hence Vetiver has got a great future potential. International organization such as 'The Vetiver Network International' (TVNI) is established to promote the worldwide use of Vetiver System (VS) especially in soil erosion, wastewater treatment and phytoremediation, for a sustainable environment. The heavy metal absorbing capacity of this grass is regarded as a boon by environmentalists.

The research work on Vetiver is mostly concentrated on essential oil components, the heavy metal tolerance and its role in soil erosion control. But at the same time, less work is done on other physiological aspects of Vetiver grass, except very few reports such as Farooqi *et al.*, (2010) carried out some physiological work in Vetiver grass. It is now very well realized that manipulation

of growth development and chemical composition of the plants in possible through particular use of plant growth regulators either alone or in combination. With this view an attempt has been made in the present investigation to study biochemical responses of Vetiver grass to foliar application of well known plant growth retardant chlorocholine chloride (CCC), recently introduced plant growth promoter triacontanol (Vipul) and an aromatic acid- salicylic acid (SA) which is attaining a status of phytohormone due to its variety of effect on plants. Fate of carbohydrate, pigment status, mineral uptake and activities of some enzymes has been investigated.

Some of the significant findings of the present work can be summarized as follows-

Effect of PGRs on growth parameters

The growth of roots is economically more important in case of Vetiver grass; the PGRs like CCC, SA and Vipul all positively influenced the root growth of both the varieties- KS1 and local. In case of local variety, 200ppm Vipul concentration caused maximum dry matter production. In case of KS1 Vetiver variety, SA treatment is more effective to increase all growth parameters like tiller number, root and shoot dry matter partitioning. Hence in case of KS1 variety, SA is more effective PGR, which positively influenced the growth.

Effect of PGRs on photosynthetic pigments

The level of photosynthetic pigments- chlorophylls and carotenes were considerably higher in improved cultivar KS1 than the local cultivar and this indicates a higher photosynthetic efficiency of improved cultivar. But at the same time it was noticed that in contrast to improved cultivar local cultivar accumulated more photosynthetic pigments in response to application of PGR. Among the three PGRs Vipul was most effective in this respect.

Effect of PGRs on Anthocyanin content

Higher concentration of CCC (200ppm) only causes elevation in anthocyanin content in case of leaves of local variety while all other treatments caused reduction in anthocyanin content in both (local and KS1) varieties. The anthocyanin pigments play important role as protection against ultraviolet reaction as well as pathogen defense. But the treatment did not prove useful in elevating the level of these pigments.

Effect of PGRs on Polyphenol content

A clear varietal difference was observed polyphenol content in leaves of the two Vetiver varieties (KS1 and local). Leaves of KS1 possess high amount of polyphenol as compared to local variety and this plays important role in disease resistance as well as free radical scavenging. But application of the three PGRs caused a lowering of polyphenol contents in leaves of this variety. On the other hand in local variety treatment with higher concentrations of CCC and SA caused increase in polyphenol content in leaves, hence proves beneficial.

Effect of PGRs on activity of enzyme Nitrate Reductase

Foliar application of all three PGRs (CCC, SA and Vipul) has stimulatory effect on *in vivo* activity of NR in roots and leaves of KS1 variety and in leaves of local variety. Higher concentration of Vipul has stimulatory effect on NR activity in roots of KS1 and leaves of local variety. Salicylic acid treatment caused significantly increase in enzyme activity of both the Vetiver varieties. Nitrate reductase represents the most important enzyme catalyzing the first step of nitrogen assimilation in plants.

Effect of PGRs on activity of enzyme Peroxidase

No marked alterations in peroxidase activity were noticed in Vetiver roots due to foliar treatment of the three PGRs in present investigation. Since peroxidase

plays multiple role in plant metabolism. Such behavior of the enzyme in Vetiver is rather peculiar.

Effect of PGRs on activity of enzyme Acid phosphatase

Both low and high doses of Vipul and higher dose of CCC caused significant increase in acid phosphatase activity in roots of both cultivars- KS1 and local. Such increase in this hydrolytic enzyme may cause positive effect on phosphorus uptake process.

Effect of PGRs on carbohydrate content

The level of reducing sugar and total sugars was increased in leaves and roots of Vetiver grass respectively while the starch content was found to be increased in roots of local Vetiver variety in response to all the three PGRs. Such increase is not observed in case of variety KS 1 except that the starch content was increased in roots in response to 200ppm SA.

Carbohydrates are main photosynthetic product of plants, which play a very important role in growth and overall metabolism in plants. An increase in the level of these compounds reflect a general shift towards anabolic processes by the action of PGRs. Such shift is quite prominent in the Local cultivar of Vetiver.

Effect of PGRs on mineral contents

Potassium

The level of potassium in roots was increased by both the concentrations (100ppm and 200ppm) of Vipul, in both the Vetiver varieties. Accumulation of the potassium is more in roots may prove beneficial for the root growth as well as in its metabolism. Hence, Vipul is beneficial to both the varieties in this respect.

Calcium

The treatment of CCC, SA and Vipul in general caused increase in Ca^{++} leaves of both varieties. All PGR treatments caused increase in calcium level in roots of Vetiver variety KS1 while that of decrease in roots of local variety. Among the three PGRs, higher concentration of SA was very much effective to increase calcium content in roots of KS1 variety.

Magnesium

The treatment of CCC, SA and Vipul did not caused any significant change in magnesium level in roots and leaves in plants of both Vetiver varieties (KS1 and local). Thus magnesium uptake, transport and accumulation appeared to be insensitive to application of both growth promoter as well as growth retardant.

Iron

The iron content in root tissue was found to be increased by foliar application of all the PGRs are beneficial for improvement in root iron level and this can positively influence the root metabolism in view of key role of this element.

Effect of PGRs on essential oil

Qualitative analysis of essential oils in roots of two varieties was made with TLC. About 8-9 different constituents were detected in essential oils of both the cultivars. The level of many of these components was found to increase by application of CCC and higher concentration of Vipul in local Vetiver variety. Similar situation was noticed in response to Vipul and application of higher concentration of SA of cultivar KS1. Essential oil is economically very important component in Vetiver grass; hence Vipul is effective in case of both the varieties of Vetiver while CCC in case of local variety and higher concentration of SA in case of KS1 variety are effective.

In conclusion it can be studied that foliar application of the three plant growth regulators (chlorocholine chloride, salicylic acid and Vipul) have brought about marked biochemical changes in the leaf and root tissue of both Vetiver cultivars. However the two varieties differ with respect to nature and pattern of these changes. On the whole application may prove advantageous for this essential oil yielding plant.