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Effects of Different Concentrations of Laundry Detergents on *Coleus* Growth

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Supervisor Declaration

I certify that this research project entitled "Effects of Different Concentrations of Laundry Detergents on *Coleus* Growth" was written under my supervision.

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Dedication

This research paper is dedicated to our parents who gives their outmost support, and never-ending inspiration throughout the study. They are the one who provide the resources that needed in the making of this study. It also dedicated the teachers who are behind in making this research possible through guiding the researcher to complete this study.

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Aim of the study:

The main objective of this study is to determine that to which extent these detergents have an inhibitor effect on plants, and then evaluate which concentration to use affects weakening and obstacles plant growth.

Furthermore, To study the different aspect of changes that plant make in themselves to survive the chemical water stress from laundries, household wastes, etc.

INTRODUCTION

Coleus is an aromatic perennial, with an erect stem and tuber like roots, reaching 60 cm. (Prajapati et al., 2003). Coleus is a member of the mint family and native to India, and grows in the subtropical temperate climates of India, Nepal, Thailand and Sri Lanka. Coleus is 1 to 2 feet tall having teardrop striking leaves, shimmering green framing a bright purple center; leaf color differs with the amount of shade. Flowers are of pale purple or blue color (Khan et al., 2012).

Coleus forskohlii Briq. belongs to the family Lamiaceae and it is one of the most significant potential medicinal crop. It is a perennial herb and having fleshy and fibrous roots. The tuberous roots are found to be rich sources of forskolin (Colenol), a diterpenoid ($C_{12}H_{34}O_7$) that is being developed as a drug for hypertension, glaucoma, asthma, congestive heart failures and certain types of cancer. Roots are believed to have blood purifying action. The forskolin content varies from 0.1%-0.4% in medicinal coleus .(Muruganandam et al., 2021)

Coleus forskohlii Briq is a perennial, branched, aromatic herb, belonging to the botanical family of Lamiaceae (Labiatae). It is called Gandhamulika in Sanskrit, Pashanbhed in Hindi, Markandiberu in Kannada and Marunthu koorkankizhanku in Tamil. It is one of the 10 species of the genus Plectranthus, having greatest number of synonyms and most number of uses. Its synonyms are Coleus barbatus Benth, Plectranthus barbatus Andrews, Plectranthus forskalaei Willd, Plectranthus kilimandschari (Paul et al., 2013).

Plectranthus *Plectranthus forskalaei Willd*

Coleus barbatus Benth

TAXONOMICAL CLASSIFICATION

Taxonomical classification of this plant has always provided better contribution to conserve existing plant names, for the benefit of researchers, botanists, taxonomists, pharmacognocists and other users. A concise taxonomical classification of *Coleus* forskohlii is presented in Table 1(Khan et al., 2012).

Table 1: Taxonomical classification of C. forskohlii

Kingdom	Plantae
Phylum	*Angiospermae*
Class	*Dicotyledoneae*
Order	*Tubiflorae*
Family	*Lamiaceae*
Genus	*Coleus*
Species	*forskohlii*

Plant morphology

Coleus plants are aromatic perennial and have tuber like a good typically golden brown in colour. C. forskohlii has diverse growth forms and the roots are harvested in the fall season when the color is bright and the roots are most concentrated in forskolin (Alternative Medicine Review, 2006). Coleus is warm temperate and subtropical plant species naturally growing at 600 to 1800 m altitude. Plant grows on sunny hill slopes and plateaus in arid and semi-arid climates. Coleus inhabits sandy-loam or loamy soil with 6.4 to 7.9 pH. Plant is herbaceous with perennial rootstock and annual stems. Plants from different ecogeographic areas differ greatly in their morphology. Growth habit is strikingly variable, being procumbent, decumbent or erect. Shoot height ranges from 15.0 to 120 cm. Lamina length differs from 1.5 to 15.5 cm2. Inflorescence length varies from 3 to 40 cm. Morphology of root differs in different populations being fibrous, tuberous or semi-tuberous. Fresh root yield in different populations differs from 1 to 500 g/plant. Forskolin content in roots ranges from 0.07 to 0.58% of dry matter (Virbala and Kalakoti, 1994). C. forskohlii is a perennial plant that grows to about 45 - 60 cm tall. It has four angled stems that are branched and nodes are often hairy. Leaves are 7.5 to 12.5 cm in length and 3 to 5 cm in width, usually pubescent, narrowed into petioles. Inflorescence is raceme, 15 - 30 cm in length; flowers are stout, 2 to 2.5 cm in size, usually perfect and calyx hairy inside. Upper lip of calyx is broadly ovate. The blue or lilac corolla is bilabiate. Lower lobes are elongated and concave so that they enclose the essential organs. The ovary is four parted and stigma is two lobed and the flower is cross-pollinated by wind or insects (Bailey, 1942). The root is typically golden brown, thick, fibrous and radially spreading. Roots are tuberous, fasciculated, 20 cm long and 0.5 to 2.5 cm in diameter, conical fusiform, straight, orangish within and strongly aromatic. C. forskohlii is the only species of the genus to have fasciculated tuberous roots. The entire plant is aromatic. The leaves and tubers have quite different odours. However, the growth habit of C. forskohlii is strikingly variable being erect, procumbent or decumbent. Similarly, the root morphology in different populations is also fascinatingly diverse, being tuberous, semi tuberous or fibrous .(Kavitha et al., 2010)

soil Conditions and Preparation:

Plant coleus in a porous, fertile, welldrained loam soil. Keep the soil barely moist at all times. They grow best in a soil pH of 6.5 or lower. Any soil suitable for bedding plants is ideal. If the soil has a clay texture, adding some sand or coarse bark may help. Prepare the beds a few weeks before planting if coleus are to be planted in new beds. Work the soil, preferably with a power tiller, adding amendments as necessary.

Planting and Blooming:

The best time to plant coleus is spring, or when the danger of frost has passed. Coleus are normally used as garden annuals rather than as perennials because they are one of the first plants to be killed by frosts in the early winter. The choice in coleus is unlimited. There is a cultivar for almost every color, leaf shape and variegation you can imagine. Colorful leaves in red, green, pink, white, purple and yellow are only some of the choices. Small insignificant flowers will appear in late summer. Remove the flower spikes to induce continuous production of new foliage. A plant usually stops growing when it starts flowering. Plants grown in heavy shade may become straggly and need frequent pruning to maintain a low, dense form. Dwarf, more compact forms are also available in addition to the standard varieties. All varieties grow rapidly. In late fall before the first frost, cuttings from favorite cultivars may be taken, rooted for overwintering and replanted outdoors the next spring.

Watering and Fertilizing:

Watering is often necessary to achieve good foliage. Coleus do not tolerate wet feet, so make extra sure the soil has good drainage and that the watering is strictly monitored. Too much water will reduce vigor and make the plants more susceptible to diseases and root rot. In south Louisiana’s hot summers, it’s important to make sure the beds or containers stay moist but not overly wet. Modify the watering schedule according to growth and temperature. Fertilize established plants once or twice during the growing season. Use a slow-release fertilizer at the rate of 1-2 pounds of nitrogen per 1,000 square feet of bed area.

Types of plant growth inhibitors:

The high level of organization of living organisms, including the plants, presupposes the presence of complex and multiple relations with the environment. The influence of the environment on the plant organism is determined both by the strength and duration of the corresponding factor and by the interaction between the factor and the genetic peculiarities of the plant. For each of the numerous physiological processes, constituting the live system, there always exists the so-called “stability limit”. Each deviation of the environmental factors out of this stability limit of the live system results in stress, which to a different degree disturbs its structure and functional activity. The range and importance of these effects depend on the genetically determined plant capacity and sensitivity, as well as on the intensity and duration of the stress, when applied alone or in combination. (Bhadula et al., 1998; Chaves et al., 2009)

Soil structure affects the behavior of plants in many ways. The most obvious effect is on the appearance of the roots, which are generally smooth and cylindrical in friable soil, but are stubby and gnarled in compacted soil and are greatly restricted in their range, with potentially deleterious effects on the supply of water and nutrients. In addition, there are many less obvious but often equally influential effects on the overall performance of the plant. The soil may sometimes be too porous for the roots to make enough contact with the solid and liquid phases to extract seemingly available nutrients or water. The presence of macropores (continuous large pores that roots preferentially occupy) may enable the roots to traverse otherwise impenetrable soil, and thereby gain access to a larger reservoir of water and mobile nutrients. Such macropores are not only different physically, but also chemically and microbiologically, from the bulk soil, and may be enriched in pathogenic or symbiotic microorganisms or depleted of nutrients, so that roots growing in them may be affected in many ways. Finally, the structure of the soil may not only influence the current ability of the roots to provide the shoot with adequate water and nutrients; it may also induce roots in adverse soil to send inhibitory signals to the leaves even though the roots are currently able to take up adequate water and nutrients.emphasizing especially effects on the overall growth of plants, but ignoring the well-established indirect effects arising from the influence of structure on the aeration of the soil (Zlatev et al., 2012).

The quantitative analysis of plant growth is a branch of plant physiology to which adequate attention has not as yet been paid, but which should be able nevertheless to yield results of much theoretical interest and economic importance. Methods for obtaining data for the analysis of plant growth under ordinary cultural conditions are in general simple, consisting principally of periodic dry-weight and leaf-area measurements (Briggs et al., 1920).

The Inhibiting Action of Unsaturated Lactones on Growth. -The inhibiting effect of a number of unsaturated lactones on seed germination and root elongation has been reported by many workers. However, seed germination is an obscure process and appears to involve root elongation, which is auxinsensitive, as well as the complex of enzyme activations participating in germination proper. Fortunately, the lactones also exert a clear-cut inhibition on a well-studied growth process. This was first made clear by Veldstra and Havinga using coumarin as the unsaturated lactone, and studying the curvature of split pea stems in auxin solutions. confirmed the effect on split pea stems on several occasions' curvature is inhibited by concentrations of 1.10-4 M and above; the inhibition is complete, i.e., the inward curvature is abolished, at about 3.10-3 M. As with arsenite threshold concentration depends somewhat on the concentration of auxin used; i.e., the higher the auxin concentration the larger the curvature of the uninhibited controls and the lower the concentration of coumarin which shows a detectable effect. The inhibition is not removed by adding malate or other organic acids (Thimann and Bonner Jr, 1949).

The mechanism of growth promotion by Trichoderma is unknown but, in some instances, may involve control of minor pathogens. Thus, some soils suppressive to plant pathogens such as Pythium and Rhizoctonia have been found to contain high levels of Trichoderma. This biocontrol activity may involve competition for infection sites or substrates on the plant surface, physical restriction, antibiosis, or production of lytic enzymes. Nevertheless, the direct stimulation of plant growth by Trichoderma cannot be ruled out. Plant growth inhibition has also been reported (Ousley et al., 1993).

Plant protease inhibitors (PIs) are commonly recognized as a significant component of natural plant defense, as they inactivate digestive proteases upon insect herbivory. Early on, plant PIs were expected to be good candidates for expression in transgenic crops to avoid crop loss. However, success has been hindered by the rapid adaptation of insect pests to the inhibitors. The long history of close association between phytophagous insects and their host plants has led to sophisticated physiological responses in insects to dietary PIs. Under both natural and agricultural conditions plants are often exposed to various environmental stresses. Drought is one of most important environmental factors inhibiting photosynthesis and decreasing growth and productivity of plants. It is one of the major causes of crop loss worldwide, reducing average yields for most major crop plants by more than 50%. Under these stress conditions usually a water deficit in plant tissues develops. In the last years effects of water deficit were studied on different levels from ecophysiology to cell metabolism (Zhu-Salzman and Zeng, 2015).

Chemical inhibitor:

A variety of substances which can prevent the active movement of auxin in plants is now known. it is at least possible that some of them may act by a common mechanism, and those that do would therefore be expected to have some similarities with respect to physical and chemical properties, enabling them to act at the same active site. It is known that many compounds which inhibit auxin transport also have the ability to abolish the root geotropic response although the nature of the relationship between these two processes has yet to be defined. The structural requirements of auxin transport-inhibiting compounds are of interest because such knowledge should assist in defining the physiological processes which are involved and lead to possible mechanisms by which they act. Recently it has been shown that a class of compounds which affect the root geotropic response can be defined by a common set of chemical and physical parameters, and since it may be that some of the chemicals which affect both processes achieve their result by a common mechanism, the extent to which the same parameters were required for activity with respect to auxin transport was investigated (Katekar and Geissler, 1977).

Amino Acid Synthesis Inhibitors:

The amino acid synthesis inhibition mode of action includes herbicides from the following chemical families: sulfonylureas, imidazolinones, triazolopyrimidines, epsp synthetase inhibitors, and the glutamine sythetase inhibitors. The sulfonylureas, imidazolinones, and triazolopyrimidines are also known as ALS or AHAS inhibitors. All of the herbicides within this mode of action act upon specific enzymes to prevent production of amino acids. Amino acids are the “building blocks” for proteins for plant growth and development of a plant. Given the large number of families in the mode of action there are many product names from these herbicide families including, Classic(ALS), Pursuit (ALS) Roundup (EPSP), and Liberty (Glutamine).

Seedling Growth Inhibitors:

The seedling growth inhibition mode of action is a mode of action that interrupt new plant growth and development. Herbicides within this mode of action must be soil applied and either inhibit root or shoot growth in emerging plants. carbamothiates, acetamides, and the dinitroanilines make up of the herbicide families within this mode of action. Common trade names in this mode of action include Eptam, Dual, Harness, Prowl, and Treflan.

Photosythetic Inhibitors:

Photosynthetic Inhibitors are one of the next major modes of action that were developed following the growth regulators. Herbicides within the photosynthetic Inhibitor mode of action as their name implies inhibit one of several binding sites in the process of photosynthesis. Without photosynthesis the plant cannot make food. In addition several secondary destructive compounds are produced during the inhibition of photosynthesis and therefore the cause of target plant death is more than simple starvation. Since the herbicides within this mode of action inhibit photosynthesis the herbicides only start working once the plants have emerged and are exposed to light. Families within the mode of action include triazines, uracils, phenylureas, benzothiadiazoles, nitriles, and pyridazines. Common herbicides include Atrazine, Sencor, Hyvar, Karmex, Basagran, and Buctril.

Lipid Synthesis Inhibitors:

The lipid synthesis inhibitors typically inhibit the synthesis of plant lipids. If lipids are not produced within the plant then production of cell membranes is unable to proceed and new plant growth is halted. The aryloxyphenoxypropionates and the cyclohexanediones are the two families within this mode of action. Examples of trade names of products within this mode of action include Poast, Assure II, and Select.

Natural growth inhibitors:

Natural growth inhibitors are regulating substances which retard such processes as root and stem elongation, seed germination, and bud opening. These regulators actively depress growth of isolated stem sections and act as antagonists to the plant hormones such as auxin, gibberellin, and cytokinin. For a long time the chemical nature of growth inhibitors was obscure, but in the middle of the 1940s toxic substances which may inhibit growth were isolated from guayule roots, and one of them was identified as cinnamic acid by Bonner & Galston. The derivatives of cinnamic acid were found to be active inhibitors of some growth processes. Some pure flavonoids and coumarins are also able to inhibit coleoptile section elongation, stems, bud Dpening, and seed germination. It is now clear that not all natural phenolic compounds are growth inhibitors. Abscisic acid (ABA) is a considerably stronger inhibitor than phenolic compounds and was often detected on chromate-grams with phenols in the, -inhibitor complex. Therefore the growth inhibiting activity of some phenolic fractions, observed previously on onedimensional chromatograms, could be due to ABA (Kefeli and Kadyrov, 1971).

Natural Proteinase Inhibitors:

There are many ways in which the action of proteolytic enzymes may be controlled by the living organism. One form of control employs proteinase inhibitors, a group of polypeptides, proteins, and glycoproteins. These inhibitors occur in numerous plants and animals. Their methods of isolation are discussed briefly. The inhibitors are differentiated with regard to their mode of action — permanent, temporary, and progressive inhibition — also with regard to their specificity and some physicochemical properties. In the case of temporary inhibition a distinct peptide bond in the reactive site of the inhibitor is split by the respective enzyme. The elucidation of the three dimensional structure of the polyvalent basic inhibitor from bovine lung offers another opportunity to clarify the molecular mechanism of the enzyme — inhibitor reaction. Our present knowledge of their physiological significance is discussed with respect to various inhibitors. The growth retarding effect in experimental animals which are fed leguminosae is partly caused by proteinase inhibitors. Recent experiments show that the inhibitors in solanaceae are a reserve protein, which is not degraded enzymatically and which is found in different plant tissues depending on the state of development of the plant. Furthermore a protective function of the inhibitors is discussed. The physiological significance of the inhibitor from vesiculary glands and from sperm plasma is the best known compared with other mammalian inhibitors. This inhibitor is involved in the process of decapacitation by complex formation with the acrosomal enzyme acrosin of spermatozoa. The biosynthesis of this inhibitor is hormone dependent. In the human female cervical secretion, an inhibitor has been demonstrated, which may influence the sperm migration through the cervix. Possibly an inhibitor from colostrum protects colostral immune bodies from undue degradation in the gastrointestinal tract of the newborn. The primary structure of the bovine colostrum inhibitor resembles that of the polyvalent basic bovine inhibitor to a fairly high degree (Werle and ZICKGRAF-RÜDEL, 1972).

Mode of Action, Inhibitor Specificity, and Reactive Centre:

The inhibitors are classified not only with respect to their specificity, to their molecular weight, and other physicochemical properties, but also with respect to the types of inhibition. There are 3 main types of inhibition

1. The permanent inhibition with the following criteria:

a) the equilibrium of inhibition is reached within seconds or a few minutes.

b) The rate of attainment of equilibrium is virtually independent of the temperature of incubation.

c) The degree of inhibition remains unaltered for days.

d) The inhibitor enzyme binding is reversible. To this group belong many inhibitors both from plants and animals.

2. Temporary inhibition. The criteria for this type are the same as for permanent inhibition, but the degree of inhibition is slowly diminished with time of incubation because the inhibitor is destroyed by the enzyme. In this way the enzyme becomes active again. To this group belong most of the polypeptide inhibitors.

3. The progressive inhibition (slow reacting inhibitors). Here attainment of equilibrium takes some hours at 25—37°. The reaction is strongly temperature dependent. The complex bonding is irreversible. This type of inhibition is hitherto known only for inhibitors from blood plasma.

Detergents:

Detergents are materials which aid in the removal of dirt or other foreign matters from contaminated surfaces (Yahaya et al., 2011). They have the ability to remove dirt from porous surfaces (such as fabrics and clothes) and non porous surfaces (such as metals and plastics). Because of this, detergents are widely used in both industrial and domestic premises. They are used to wash clothes, vehicles, equipment, installations and heavy duty machines. They are also used in dispersing oil spills at sea and in pesticide formulations for agricultural purposes (Lightowlers, 2009). Earlier, detergents were made by treating an aromatic or benzene type compound with sulphuric acid followed by neutralization with alkali to convert the product to its sodium salt. These detergents however became a public nuisance because unlike soaps, they were neither soluble nor biodegradable; that is once put into water they tended to remain there, resisting conversion into less complex and more soluble substances. The aromatic compound was later replaced with a so called linear alkyl type compound in the process described above and the detergent produced was as effective as the former kind in its detergent action and was more biodegradable

(Yahaya et al., 2011). Detergents generally are composed of surfactants, builders, alkalis, enzymes, anti-redeposition agents, active oxygen bleaches , anti microbial agents, fabric softeners, fragrances, optical brighteners, preservatives, foam regulators, hydrotropes and processing aids.The increasing environmental pollution arising from detergent use is becoming a growing concern. Lack of information on the effects of detergent on living organisms makes people to handle or dispose detergents carelessly. Therefore, a thorough investigation on the ecological disorder that may arise from improper handling or disposal of detergents needs to be done. This is necessary because there is no alternative to detergent for now. These days, it is common practice for people to grow vegetables near their houses so that they can have a ready supply of fresh vegetables. It has also been observed that detergents from laundry water are often released to meet the needs of these plants and yet there is insufficient knowledge on what effects these detergents could have on these crop plants (Smulders, 2002).

Effects of Laundry detergents:

Soapy wash water from dishes or laundry will help keep plants alive in an emergency, but you should be aware of certain possible problems.

Boron. Many laundry products contain boron compounds. Some have fairly high levels, which can be toxic to plants. (Plant damage from excess boron first shows up as "burning" of the leaf edges.) You won't be able to determine the boron content by reading the label on the container, but look at the trade name. If it sounds somewhat like "boron" or "borax," the product probably contains a significant amount of boron. These products probably contain either boron or metaphosphates, or both. The sodium in the metaphosphates tends to seal up the soil; the boron may accumulate enough to become toxic to plants (Ehilen et al., 2017).

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