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INFERENCE OF THE APPLICATION OF POLYACRYLAMIDE ON ESSENTIAL OIL AND ACTIVE CONSTITUENTS OF LEMONGRASS

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ABSTRACT

Lemongrassis an important aromatic, anti-microbial crop that checks the viability of tumour cell. Citral is its active constituent that is used in preparation of ionones and artificial perfumes. Keeping this in mind, the importance of crop, a pot experiment was conducted as a factorial randomized design to find out the effect of basal application of polyacrylamide on lemongrass. Polyacrylamide is a long chain, synthetic and a high molecular weight polymer. Treatments include six basal levels of polyacrylamide *viz.*Pam_0,Pam_{224}, Pam_{448}, Pam_{896}, $Pam_{1792}$and Pam_{3584}. The result showed that the basal application of Pam_{1792} proved best for essential oil, citral content and its yield particularly of variety Krishna.

INTRODUCTION

Among various plants assessed for their essential oil bearing medicinal importance, *Cymbopogon flexuosus* (Steud.) Wats. (lemongrass) has been recognized as a rich source. Lemongrass is a perennial, multiharvest, sweet-smelling, industrial cash crop and is cultivated for its essential oil all over the world (Akhila, 2009; Lonkar *et al*., 2013). Lemongrass oil has a promising anticancer activity and causes reduction in tumour cell viability by activating the apoptotic mechanism (Chaouki *et al*., 2009; Sharma *et al*., 2009). It is an invigoratory, antiseptic, astringent, anti-depressant, allopathic and anti-inflammatory (Katsukawa *et al*., 2010). The oil is also used as insect repellant and in flavouring essence, perfumery and cosmetic and other industries (Harbone, 1998; Sharma *et al*., 2000; Schaneberg and Khan, 2002). The active constituents of essential oil is citral, a cyclic monoterpene. Citral is responsible for lemon odour of the plant and owing to the prefix lemon. Citral is a combination of two isomeric aldehydes, namely geranial (α-citral) and neral, i.e. β-citral (Pengelly, 2004). The natural citral is used as an essential raw material for the synthesis of β-ionones that is used for the synthesis of a number of useful aromatic compounds, including vitamin A.

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There is an ever increasing global demand of lemongrass oil due to its medicinal and aromatic properties. India has been exporting lemongrass oil for many years. For example, during 1 March 2016 to 9 March 2016, lemongrass oil was exported approximately of worth rupees 10 crores (www.infodrive.com lemongrass). Keeping its importance as foreign money earner in view on one hand and its indigenous demand for multipurpose use of its essential oil and active constituent (citral) on the other, it is imperative to increase its production. Due to lack of land area it is difficult to bring more land under lemongrass cultivation. The only alternative is to increase its per hectare productivity. Among various factors, like in other crops, soil moisture play important roles in increasing productivity of lemongrass. Soil moisture is usual important factor. Its adequate supply helps in obtaining the optimum growth and development of plants by maintaining proper water potential of cells. While, deficient or excessive soil moisture results in improper water balance leading to poor performance of plants. The soil moisture may be lost due to several factors including run off and soil losses due to erosion and infilteration. To check the moisture loss to a great extent, application of polyacrylamide (Pam) to the soil may be an effective soil moisture conservation practice (Tumsavas and Kara, 2011). It is a long chain, synthetic, high molecular weight polymer made by the polymerization of acrylamide monomers with each other or with other vinyl monomers to yield products with extremely high molecular weight in the proper conditions (Barvenik *et al*., 1996). It may be of three types due to charge characteristics. These include anionic, cationic and non-ionic. The degree of positive and negative charge is called charge density. These polymer macromolecules react with the linear particles of the soil, aerate the soil and provide water to the plants (Zlatkovic and Raskovic, 1998; Vacher *et al*., 2003).

MATERIALS AND METHODS

Authentic plant-slips of Lemongrass varieties *viz*. Krishna and Neema were procured from Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, India.

Plant-slips were surface-sterilized with 0.2% $HgCl_2$ solution for 5 min with frequent shaking, followed by repeated washings with deionized water. Each earthen pot (25 cm diameter × 25 cm height), used in this experiment, contained 5 kg of homogenous mixture of soil and organic manure in the ratio of 4:1. A basal fertilizer dose consisting of nitrogen, phosphorus and potassium (15-25-25 kg ha^{-1}) was given uniformly prior to sowing. The soil was maintained at proper moisture to ensure better growth of the plants.

Experimental set up

The experiment was conducted in the naturally-illuminated environmental conditions in the net house of the Department

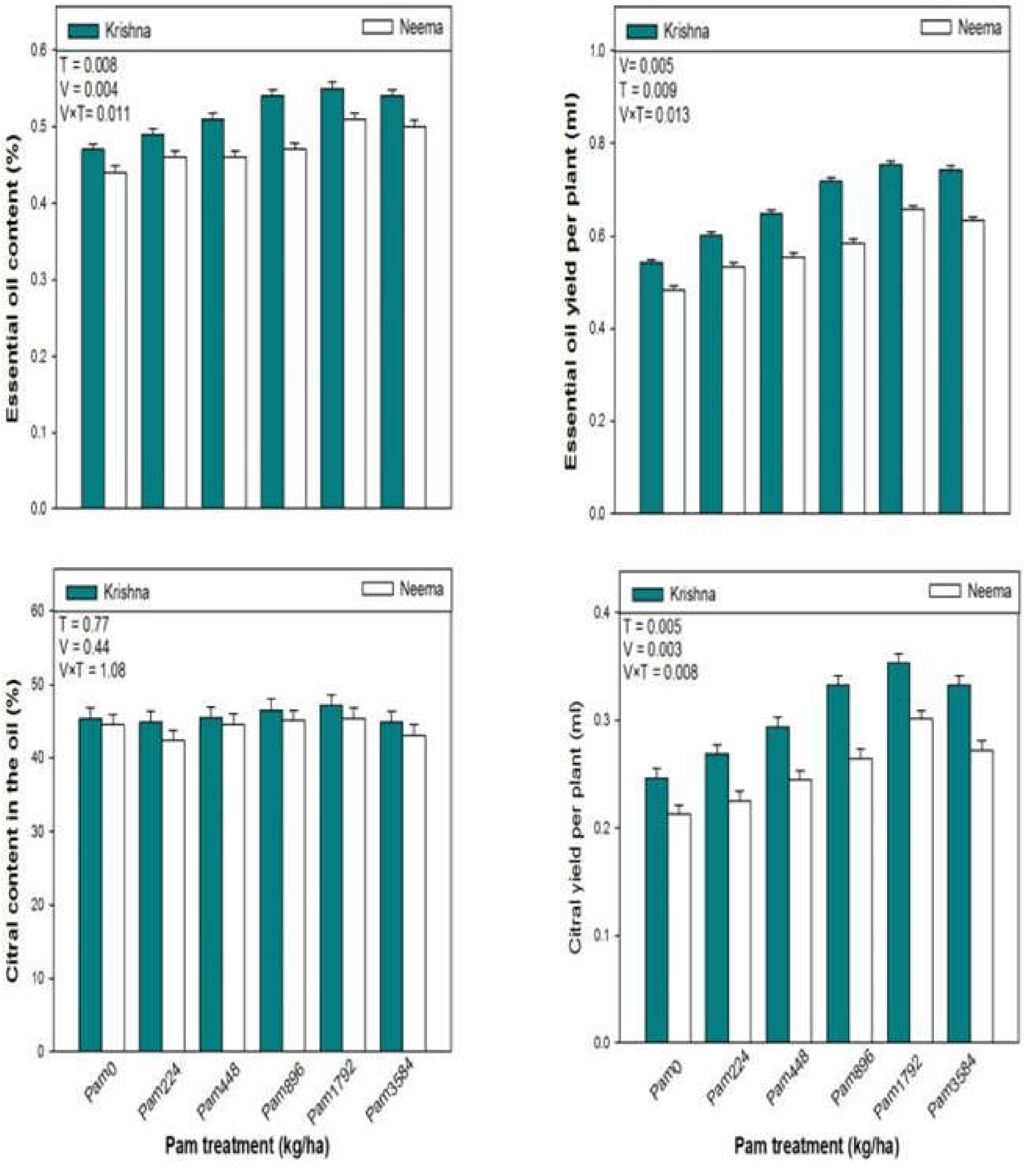

Figure 1. Effect of six basal doses of Pam on yield parameters (essential oil content, essential oil yield per plant, citral content in the oil, citral yield per plant) of two varieties of lemongrass. Error bars (┬) show SE

of Botany, Aligarh Muslim University, Aligarh (27° 53′N latitude, 78° 51′E longitude, and 187.45 m altitude). The pots were arranged according to factorial randomized blocks design.

The treatment of six doses of Pam at 0, 0.5, 1.0, 2.0, 4.0 and 8.0 g Pam per pot, i.e. (0, 224, 448, 896, 1792 and 3584 kg Pam/ha (Gupta, 2004) were applied directly to the soil at the time of transplanting.

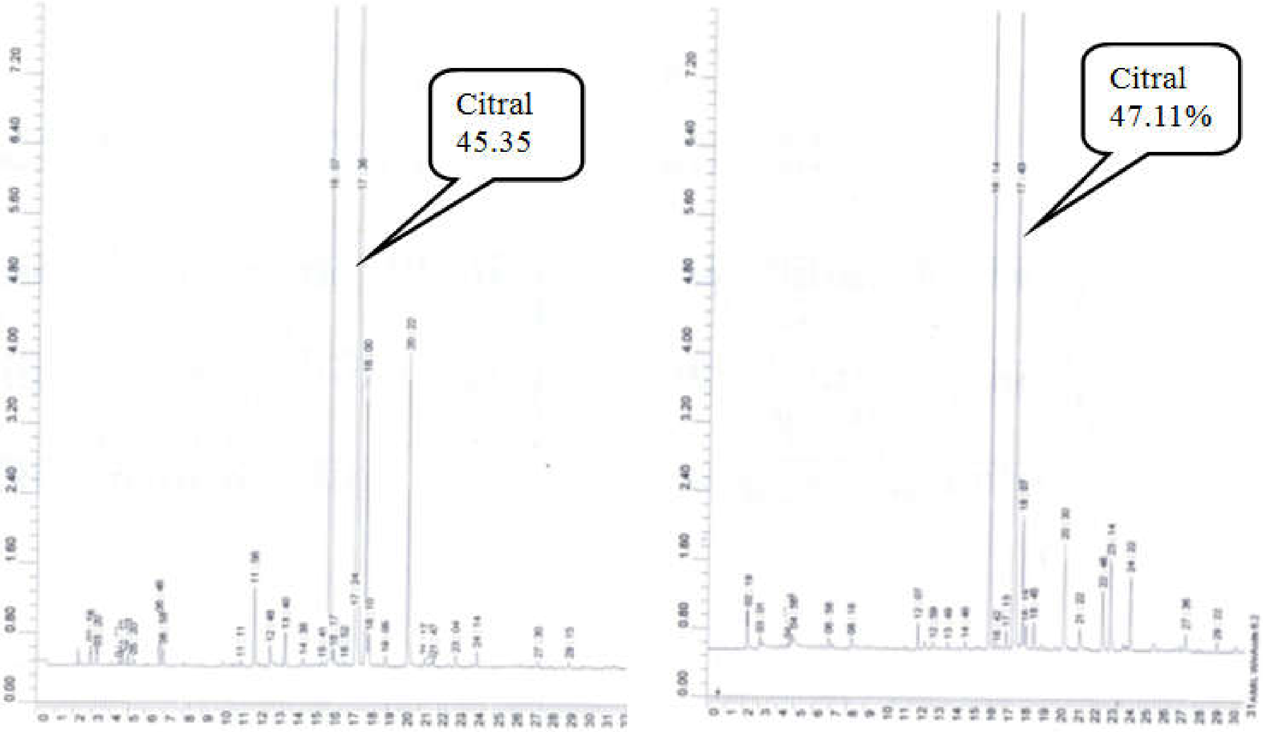

Figure 2a. Chromatogram showing various components of essential oil of Krishna Variety of lemongrass grown with basal Pam$_0$ and basal Pam$_{1792}$

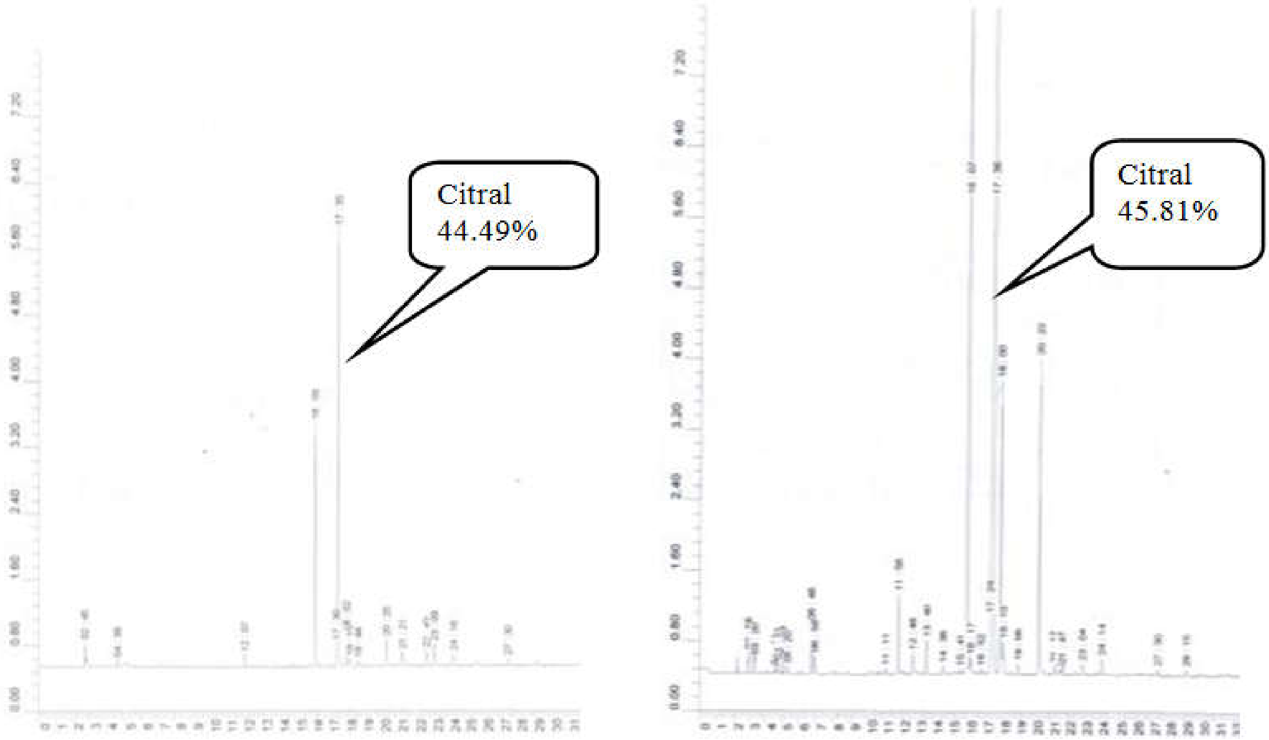

Figure 2b: Chromatogram showing various components of essential oil of Neema Variety of lemongrass grown with basal Pam$_0$ and basal Pam$_{1792}$

Physical and chemical properties of the soil used in the experiment were determined according to Jackson (1973). The soil was sandy loam with pH 7.8, organic matter 0.35% and electrical conductivity 0.5 mhos cm^{-1}. The initial content of soil N, P and K was 98.4, 7.1 and 141.8 mg kg^{-1}, respectively. Performance of the crop was assessed in terms of essential oil content, yield and main components of the oil which were determined at 180 DAS.

Extraction and estimation of essential oil

Essential oil of lemongrass was extracted using a Clevenger's apparatus. This is a continuous distillation apparatus in which the separated volatile oil is caught in a trap. The apparatus consists of distillation flask with a heating mantle, still head, graduated measuring tube, levelling tube and return tube together with a condenser fitted in one piece. The leaves were chopped into small pieces in order to get maximum quantity of oil. These chopped leaves were transferred to a flask containing DDW. The flask then connected to the still head of Clevenger's apparatus. Before heating the distillation flask, water was run into the graduated receiver keeping the tap opened until the water overflowed. The contents of the flask were then heated using a heating mantle. The distillation was continued at a rate which kept lower end of the condenser cool by the continuous supply of tap water with the help of rubber tubes. After sometime, steam was formed in the distilling flask. The mixture of water vapour and essential oil passed into the condenser. As the distillation proceeded, the distillate collected in the graduated part of the receiver. The oil being lighter than water and insoluble in it, floated on the top of the receiver. At the end of 3 hours, heating was discontinued, the apparatus was allowed to cool for 20 min. As soon as the entire quantity of oil head entered the graduated part of the receiver, the volume was recorded. The measured amount of essential oil was taken to be the content of essential oil in leaves sample. The content of essential oil was expressed as a percentage on v/w basis.

Estimation of citral content

The citral contents were estimated in the essential oil of lemongrass using a gas liquid chromatograph (GLC). Separation was performed by elution method in which a stream of carrier gas was passed through the column. A sample of essential oil was injected into the carrier gas as a plug of vapour which was swept into the head of the packed chromatographic column. When in the gas phase the compound were moved towards the column outlet, but they were selectively retarded by the stationary phase. Consequently, the entire component passed through the column at varying speeds and emerged in the inverse order of their retention by the column materials. Upon emerging from the column, the gaseous phase immediately entered a detector attached to the column. Here the individual components registered a series of signal which appeared as succession of peak above a base line on the chromatogram. The area under the peak was a quantitative indication of the components. The time lapse between injection and emergence of the peak (retention time) served to identify it. Citral content was calculated by knowing the peak areas of citral given in their chromatogram. The content of citral were obtained when their peak areas were divided by the total peak areas of all components of their respective chromatograms and multiplied by 100 to determine the percentage of citral. The conditions used for the estimation of citral content in oil by gas chromatography were as follows:

Gas liquid chromatograph (GLC, Nucon 5700, New Delhi, India) was equipped with a AT-1000 stainless steel column, a flame ionization detector and an integrator. N was used as the carrier gas. The flow rates of N, H and O were maintained at 0.5, 0.5 and 5 ml/s, respectively. The temperature of GLC was throughout maintained (Detector temperature: 250°C; oven temperature: 160°C and injector temperature: 250°C. The sample size was 2 µl invariably.

RESULTS

Out of the six basal doses of Pam, Pam_{1792} enhanced the essential oil content as compared to the no Pam treated plants. Pam_{1792} showed maximum increase in the essential oil content and oil yield of both the varieties of lemongrass increasing the essential oil content by 17.02%, 16.13% and oil yield by 38.67% and 36.23% in Krishna and Neema respectively as compared to the controls (Figure 1). The basal application of Pam, 1792 also increased the citral content (active constituent of essential oil) and citral yield in both the varieties of lemongrass. The Pam_{1792} significantly increased the citral content by 3.88% and 1.91% and citral yield by 43.49 % and 41.31 % in Krishna and Neema respectively as compared to the control plants (Figure 1, 2and 2b).

DISCUSSION

There is no scientific literature available till date regarding the effect of Pam on these essential oil content, essential oil yield, citral content and citral yield. When Pam is applied to the soil, it gets adsorbed to soil particles (Malik and Letey, 1991) thereby improving the porosity, aeration, thermo and water regime, fertility and stability of soil, which in turn improve the growth and development of plants (Zlatkovic and Raskovic, 1998; Vacher *et al*., 2003). The other reason for the improvement in these parameters may be due to the nutrients made readily available by this polymer, which have been reported to increase the activity of cell division, cell expansion and cell elongation (Ananda, 2009) which directly or indirectly influence on the essential oil and its active constituents.Application of Pam would have improved soil conditions leading to better growth and development including synthesis of oil and citral content in the oil. The improvement in essential oil yield and citral yield is not surprising. Essential oil yield is computed on the basis of herbage yield and essential oil content while citral yield, on the basis of essential oil yield and citral content.

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