ABSTRACT

Lemongrass (Cymbopogon flexuosus) is an important perennial aromatic plant and natural source of citral that is used in the preparations of various perfumes. In the present study, eight lemongrass cultivars were evaluated for growth, herbage, and essential oil yield during 2018-2019 in the southern region of Karnataka, India. Results revealed that significant differences were noticed in the growth and yield parameters of eight lemongrass cultivars studied. The plant height and the number of tillers varies, ranging from 108.47-136.75 cm and 38.13-47.60, respectively. Significantly higher herbage yield (t/ha/year) was recorded in CIM-Shikar (24.25), followed by Krishna (22.50) and CKP-25 (20.72). The lowest herbage yield was recorded in the Cauvery cultivar. Essential oil content varied from 0.70-1.35% (v/w) and essential oil yield varies from 133.56-302.40 kg/ha/year in different cultivars. The amount of citral varied from 2.20% to 88.14% among eight lemongrass cultivars. The varieties arranged according to the citral content as follows, Cauvery (88.84 ± 0.99) > Nima (88.57 ± 0.70) > CIM-Shikar (84.97 ± 4.08) > OD-19 (85.90 ± 0.59) > CIM-Suvarna (82.53 ± 1.10) > CKP-25 (81.84 ± 0.30) > Krishna (79.26 ± 0.44) > CIM-Atal (2.15 ± 0.07). CIM-Atal was superior in geraniol (88.92 ± 1.00%) compared to citral (geranial and neral) content among lemongrass cultivars studied; this cultivar may be a partial replacement/substitute for geraniol rich essential oil-bearing plant in the future. Overall, cultivar CIM-Shikar was superior to other cultivars in terms of essential oil yield (302.40 kg/ha/year) and superior in citral content (84.97 ± 4.08).

Keywords: Citral content; Essential oil content; Herbage and oil yield; Lemongrass cultivars

INTRODUCTION

Lemongrass (Cymbopogon flexuosus, Family: Poaceae) is an important perennial aromatic grass with enormous pharmaceutical and industrial demand, broadly distributed throughout the world and particularly in tropical and subtropical nations (Francisco et al., 2011). Leaves of lemongrass plants are commonly used in the preparation of herbal teas and also have wide applications in food preparations. The essential oil has wide application in flavor and fragrance, pharmaceutical, aromatherapy (Shioda, 2014) and pesticide industries (Zhang et al., 2016; Antonioli et al., 2020). Lemongrass essential oil ranks in the top ten among the essential oil-bearing crops in the world mainly because of its commercial value and wide applications (Ravinder et al., 2010). The main chemical constituent of lemongrass is citral (geranial and neral) comprises more than 70-80% and it is one of the very important molecules involved in several chemical syntheses (Negrelle and Gomes, 2007). For synthesis of α- and β-ionones, citral is a base material, α-ionone is used in cosmetic, flavors and perfume, for vitamin ‘A’ synthesis β-ionone is used (Thappa et al., 1981).

There are more than 140 species in the genus Cymbopogon (Kumari et al., 2007), out of which 45 are grown in India, and lemongrass is commercially important for the production of essential oil (Hassan et al., 2007). The Cymbopogon spp. have a unique character, that they can be cultivated in different types of soils even with less fertile status of the land and have good adaptability to diverse agro-climatic conditions. The most commonly cultivated and

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economic species of *Cymbopogon* are *C. nardus*, *C. flexuosus*, *C. pendulus*, *C. citratus*, *C. khasianus*, *C. martini*, *C. winterianus*, and *C. jwarancusa*, yields essential oils which are having commercial value viz., lemongrass oil, citronella oil, palmarosa oil, ginger grass (Gupta and Jain, 1978; Rao 1997; Kumar et al., 2000). More than 60000 hectares area is under cultivation of aromatic grasses in India distributed in different states viz., Madhya Pradesh, Gujarat, Karnataka, Assam, Kerala, Maharashtra, Uttar Pradesh and Andhra Pradesh (Husain, 1994; Padalia et al., 2011).

The total demand for lemongrass oil in the world is rising, and it’s about 500 tonnes. However, its production is only about 300 tonnes; India is one of the major producers of lemongrass oil to the extent of about 200 tonnes, about 90 tonnes is exported (Singh et al., 2009). Therefore, the crop was gaining popularity due to the enormous scope and demand arising from lemongrass oil industries, leading to research and development activities for the selection of superior cultivars. There is an immediate need for the development of high-yielding essential oil-bearing cultivars and pressure on arable lands for its commercial cultivation to meet the world demand in the coming days. For profitable cultivation aspects of lemongrass, the assortment procedure depends upon the breeding plant with traits like plant height, tiller numbers, leaf area, herbage yield oil yield and citral content of the cultivar (Nair, 1982). Considering these points, eight lemongrass cultivars were evaluated in the southern region of Karnataka, India.

**MATERIALS AND METHODS**

**Experimental location**

The field experiment was conducted at CSIR-Central Institute of Medicinal, and Aromatic Plants, Research Centre, Bengaluru with eight lemongrass cultivars that were released by CIMAP. The location comes under southern region of Karnataka, with an altitude of 930m above the MSL. The latitude and longitude of the zone N:13.085 and longitude of E: 77.592, respectively, received an annual rainfall of about 925 mm during 2018 (Figure 1). The soil characteristics of the experimental site are presented in Table 1.

![Figure 1. Monthly average temperature and rainfall condition of the experimental area during 2018-2019](image)

**Table 1. Initial soil characteristics of lemongrass experimental site**

| Particulars | Values |
|-------------|--------|
| **A. Physical properties** | |
| Particle size distribution | |
| Sand (%) | 66.65 |
| Silt (%) | 22.89 |
| Clay (%) | 9.65 |
| Textural class | Sandy loam |
| **B. Chemical properties** | |
| pH (1:2.5) | 7.25 |
| EC (dS m⁻¹) | 0.65 |
| OC (%) | 0.65 |
| CEC (C mol (P⁺) kg⁻¹) | 11.75 |
| Available N (kg ha⁻¹) | 292.50 |
| Available P₂O₅ (kg ha⁻¹) | 21.75 |
| Available K₂O (kg ha⁻¹) | 90.53 |
| Available S (ppm) | 9.55 |
| Exchangeable Ca (C mol P⁺ kg⁻¹) | 1.45 |
| Exchangeable Mg (C mol P⁺ kg⁻¹) | 1.30 |
| Available Fe (ppm) | 16.58 |
| Available Zn (ppm) | 1.75 |
| Available Cu (ppm) | 1.76 |
| Available Mn (ppm) | 16.85 |

**Experimental details**

A Randomized Complete Block Design (RCBD) was adopted to carry out the experiment in the field with eight lemongrass cultivars which were replicated thrice. The experimental plot size was 3.6mx3.6m with 45cm spacing between row-to-row and plant-to-plant. RDF (Recommended dose of fertilizers) 150:40:40 kg/ha N, P₂O₅, K₂O, respectively, were applied to the soil on the planting day. The top dressing was done with 75% N with four equal splits. The crop was irrigated whenever there was a need.

**Observations**

Five randomly selected healthy plants were selected and tagged for observations. The plant height was measured during the time of harvest with a meter scale. The number of tillers per clump and the number of leaves per tillers, were recorded by counting manually. Yield parameters viz., herbage yield, and essential oil yield was calculated based on the net plot yield and converted to tone per hectare.

**Source of different lemongrass cultivars**

Different *Cymbopogon* spp. (viz., OD-19, CKP-25, Cauvery, Nima, CIM-Suvarna, Krishna and CIM-Shikar) evaluated in the present study were collected from CSIR-CIMAP, Research Centre, Bengaluru, lemongrass gene bank. The gene bank was properly maintained from its initiation in the
same piece of land with proper isolation distance and proper care was taken to avoid add mixtures of the other cultivars. Whereas, CIM-Atal geraniol rich lemongrass cultivar was recently released by CSIR-CIMAP in 2019, which was developed from Bengaluru Research Centre. The source and year of release of cultivars and other information are provided in Table 2, and their visual physical identical and morphological characteristics are provided in Table 3.

**Table 2. General information of different cultivars of lemongrass (Cymbopogon spp.).**

| Cultivars   | Plant species     | Variety Development                  | Adaptability                                             | Cultivar details references |
|------------|-------------------|--------------------------------------|----------------------------------------------------------|-----------------------------|
| Krishna    | Cymbopogon. flexuosus | Clonal selection                     | Indian Plains and hills                                  | Anonymous (1997)            |
| Cauvery    | Cymbopogon. flexuosus | Phenotypic recurrent selection       | Requires high soil moisture and is evolved for river valley tracts of Indian Plains | Patra et al (2005)          |
| Nima       | Cymbopogon. flexuosus | Half-sib seed followed by clonal selection | Indian Plains                                           | Anonymous (2003)            |
| OD-19      | Cymbopogon. flexuosus | Clonal selection                     | Adapted to a wide range of soil and climatic condition. much suited for rained cultivation | Kumar et al (2000)          |
| CIM-Suwarna| Cymbopogon. khasianus | Clonal selection                      | Drought prone areas and marginal lands                  | Lal et al (2010)            |
| CIM Shikar | Cymbopogon. flexuosus | Recurrent selection                  | High yielding cultivar (>20% Krishna)                   | Anonymous, (2016)           |
| CKP-25     | C. khasianus × C. pendulus | Hybridization                         | Grows well in northern plains                           | Rao and Sobti, (1991)       |
| CIM-Atal   | Cymbopogon. flexuosus | Selection                            | Geraniol rich (80-85%) grows well in tropical and subtropical region | Kulkarni et al (2020)       |

**ANALYTICAL METHODS**

**Extraction of the essential oil:**

The fresh leaves (100 g) of each cultivar of lemongrass (Cymbopogon spp.) were collected and subjected to hydrodistillation for 3 hours in a Clevenger-type apparatus to extract essential oil. The oils samples were dehydrated with anhydrous Na₂SO₄ and kept in a cool, dark place until further analysis.

**Table 3. Comparative analysis of physical parameters of different lemongrassflexuosus**

| Cultivars     | Krishna | Suwarna | OD-19 | Neema | Cauvery | CKP-25 | CIM-Shikar | CIM-Atal |
|---------------|---------|---------|-------|-------|---------|--------|------------|----------|
| Habit         | Semi pendent | Erect straight | Erect straight | Erect straight | Semi pendent | Erect straight | Erect straight | Erect straight |
| Height(cm)    | 75      | 81      | 80    | 73    | 82      | 115    | 126        | 109      | 130 |
| Colour        | Light brown | Light yellow | Dark brown | Reddish brown | Light purple | Light purple | Light purple | Light purple |
| Supressed internodes | 8      | 7       | 7     | 7     | 7       | 7      | 6          | 6        | 6   |
| Length(cm)    | 0.4     | 0.3     | 0.2   | 0.4   | 0.2     | 0.3    | 0.4        | 0.3      | 0.3 |
| Leaf area(cm²) | 1.54    | 1.2     | 1.42  | 2.3   | 1.38    | 1.2    | 1.38       | 1.3      |     |
| Tiller Number | 55      | 53      | 46    | 45    | 38      | 48     | 58         | 55       |     |
| Inter nodal distance | 1.6    | 1.4     | 2.3   | 1.3   | 3.2     | 0.9    | 2.5        | 2.1      |     |
| Shoot initiation Point(cm) | 20     | 15      | 14.8  | 13    | 20      | 11     | 21         | 23       |     |
| Number of Leaves | 5      | 5       | 5     | 4     | 3       | 3.4    | 5          | 5        |     |
| Midrib(cm)    | 0.6     | 0.5     | 0.7   | 0.9   | 0.6     | 0.5    | 0.7        | 0.5      | 0.5 |
| 1)Right side region | 0.6   | 0.5     | 0.7   | 0.9   | 0.6     | 0.5    | 0.7        | 0.5      |     |
| 2)Left side region | 0.5   | 0.4     | 0.6   | 1.0   | 0.4     | 0.5    | 0.7        | 0.5      |     |
**GC Method:**

Gas chromatographic analysis was performed on an Agilent 7890B gas chromatograph equipped with a flame ionization detector. For separation, an Agilent HP-5 column of 30 m length, 320 µm internal diameter, and 0.25 µm film thickness was used. Samples were injected into a split/splitless inlet maintained at a temperature of 250°C with a split ratio of 1:35. Nitrogen was used as a carrier gas with 2 ml/min constant flow rate. The column oven temperature, was programmed from 60°C and increased at the rate of 3°C/min till 240°C and held at 240°C for 2 min. The FID detector temperature was kept at 280°C.

**GC-MS Method:**

Gas chromatography-mass spectrometry analysis was performed on a PerkinElmer Clarus 680 model GC and a SQ 8C MS using an Elite-5MS column of dimensions, 30 m x 0.25 mm with film thickness of 0.25 µm. Injector temperature of GC was kept at 290°C and Helium as carrier gas with 1 ml/ min constant flow rate with a split ratio of 1:100. The column oven was programmed from 60°C to 240°C at the rate of 3°C/min. Samples were transferred from GC to MS through an inter line which was maintained at a temperature of 250°C. The ionization source of MS was at 250°C and the compounds were ionized with an ionization potential of 70eV. The mass spectrometer was programmed to scan in the range of 40 to 450 amu with a scan time of 0.8 sec and an inter scan delay of 0.01 sec. Compounds were identified by matching the relative retention index calculated using n-alkanes, (C₇₋C₃₀ hydrocarbons) and confirmed by comparing the mass spectrum of the compounds with themass spectral library.

**RESULTS AND DISCUSSION**

The growth and yield parameters of different cultivars of lemongrass are presented in Table 4. Growth traits of lemongrass varied significantly due to the different cultivars studied. The significantly higher plant height was noticed in CIM-Shikar (136.75cm), followed by CIM-Suwarna (131cm), and the lowest plant height was noticed in Cauvery. A higher number of tillers per clump was noticed in CIM-Shikar (47.60) followed by Krishna (47.53) and CKP-25 (42.13). A lesser number of tiller per clump was noticed in Nima (38.13) cultivar. This difference in the number of tillers is mainly due to dissimilarity in the inherited characters of the genotypes and variations in the environmental conditions (Singh and Singh, 1999, Sharma et al., 2005, Ibrahim and Khalidh, 2013). Similarly, results are in agreement with the findings of Lal et al. (2006), who reported plant height in the range of 100-160cm and the number of tillers/plant in the range of 45-65 for four elite clones of lemongrass. However, there was no significant difference in the number of leaves per tillers among the cultivars studied.Allard (1960) and Poehlman and Sleper (1995) reported that incidence of variation in plants occurs due to hereditary differences in the plant and environmental conditions where plants are grown or sometimes combination of both.

### Table 4. Growth and yield parameters of eight different lemongrass cultivars

| Cultivar | Plant height (cm) | Number tillers/ clump | Number of leaves per tiller | Herbage yield (t/ ha/year)* | Oil recovery (%) | Oil yield (kg/ha/year) |
|----------|------------------|------------------------|------------------------------|-----------------------------|-----------------|----------------------|
| Krishna  | 128.87           | 47.53                  | 5.08                         | 22.50                       | 1.20            | 269.98               |
| Cauvery  | 108.47           | 39.53                  | 5.08                         | 17.85                       | 0.85            | 151.44               |
| Nima     | 111.73           | 38.13                  | 5.25                         | 18.35                       | 0.90            | 164.90               |
| OD-19    | 123.85           | 41.20                  | 4.85                         | 19.05                       | 0.70            | 133.56               |
| CIM-Suwarna | 131.00         | 39.20                  | 5.17                         | 19.35                       | 1.15            | 223.17               |
| CIM-Shikar | 136.75          | 47.60                  | 5.65                         | 24.25                       | 1.25            | 302.40               |
| CKP-25   | 115.87           | 42.13                  | 4.93                         | 20.72                       | 1.20            | 247.82               |
| CIM-Atal | 122.87           | 40.67                  | 5.45                         | 20.35                       | 1.35            | 275.44               |
| SEm ±    | 1.28             | 1.59                   | 0.37                         | 1.28                        | 0.04            | 18.07                |
| CD at 5% | 3.89             | 4.83                   | NS                           | 3.88                        | 0.13            | 54.80                |

*Harvest at 8 months and 20 days second harvest was taken into account.
(275.44 kg ha⁻¹ year⁻¹) and Krishna (269.98 kg ha⁻¹ year⁻¹) recorded lower essential oil yield. The increase in the herbage yield and essential oil yield maybe due to the production of more tillers per plant, the number of leaves/tillers, plant height had a positive and strong correlation/association with yield parameters (Table 6). Verma et al. (2015) reported that cultivar Krishna recorded higher amounts of essential oil (2.35 L per 100 m²) with 80.70% of citral among eight lemongrasses evaluated under the Himalayan region of India.

Table 5. Chemical composition of lemongrass cultivars

| Cultivar   | Geranial | Neral   | Citral* | Geraniol | Geranyl acetate | G/N ratio |
|------------|----------|---------|---------|----------|-----------------|-----------|
| Krishna    | 47.38 ± 0.42 | 31.88 ± 0.01 | 79.26 ± 0.44 | 6.43 ± 0.18 | 1.98 ± 0.13 | 1.49 ± 0.01 |
| Cauvery    | 51.47 ± 0.58 | 37.37 ± 0.41 | 88.84 ± 0.99 | 0.61 ± 0.04 | 0.12 ± 0.01 | 1.38 ± 0.00 |
| Nima       | 51.94 ± 0.49 | 36.63 ± 0.21 | 88.57 ± 0.70 | 0.76 ± 0.21 | 0.31 ± 0.08 | 1.42 ± 0.01 |
| OD-19      | 52.78 ± 1.52 | 33.12 ± 2.11 | 85.90 ± 0.59 | 1.22 ± 0.10 | 0.51 ± 0.22 | 1.60 ± 0.15 |
| CIM-Suvarna | 46.94 ± 0.71 | 35.59 ± 0.40 | 82.53 ± 1.10 | 2.78 ± 0.01 | 3.02 ± 0.13 | 1.32 ± 0.00 |
| CIM-Shikar  | 50.79 ± 1.48 | 34.18 ± 2.60 | 84.97 ± 4.08 | 3.76 ± 3.30 | 2.14 ± 2.28 | 1.49 ± 0.07 |
| CKP-25     | 48.84 ± 0.18 | 33.00 ± 0.13 | 81.84 ± 0.30 | 3.15 ± 0.30 | 2.13 ± 0.06 | 1.48 ± 0.00 |
| CIM-Atal   | 1.47 ± 0.02 | 0.80 ± 0.07 | 2.15 ± 0.07 | 88.92 ± 1.00 | 2.50 ± 0.03 | 1.84 ± 0.13 |

*Citral = geranial + neral, G/N ratio : geranial/neral

With concern to the chemical composition of lemongrass cultivars studied in the present study, geranial was recorded highest (52.78 ± 1.52%) in OD-19, followed by Nima (51.94 ± 0.49), and the lowest amount was found in CIM-Atal (1.47 ± 0.02%) cultivar (Table 5, Figure 2-9). Similarly, the highest neral content was recorded in cultivar Cauvery (37.37 ± 0.41%) followed by Nima (36.63 ± 0.218%) cultivar. The market acceptability of lemongrass essential oil is determined by the amount of citral which is a combination of two stereo-isomeric monoterprenoid aldehyde compounds namely, geranial (trans isomer) and neral (cis isomer). The amount of geranial and neral constitute the total amount of citral, which is the main compound that decides the marketability of lemongrass essential oil. The citral content varies from 2.15-88.84%. The varieties arranged according to the citral content as, Cauvery (88.84 ± 0.99) > Nima (88.57 ± 0.70) > CIM-Shikar (84.97 ± 4.08) > OD-19 (85.90 ± 0.59) > CIM-Suvarna (82.53 ± 1.10) > CKP-25 (81.84 ± 0.30) > Krishna (79.26 ± 0.44) > CIM-Atal (2.15 ± 0.07). The citral content range between 72-75% was reported for Indian lemongrass collections by Kumari et al. (2009). A comparatively higher amount of citral (89%) was stated by Lal et al. (2001) for SEG 49 lemongrass clone; similarly, Ganjewala (2008) reported citral range of 82-88% for West Indian lemongrass. CIM-Atal cultivars bear low citral content compared to all other cultivars in the present study.

Table 6. Correlation of growth, yield and chemical parameters of different lemongrass cultivars

| Parameters               | Plant height(cm) | Number tillers/clump | Number of leaves per tiller | Oil recovery (%) | Herbage yield | Oil yield | Geraniol | Neral | Citral | Geraniol | Geranyl acetate | G/N ratio |
|--------------------------|------------------|-----------------------|----------------------------|------------------|---------------|----------|----------|-------|-------|----------|-----------------|-----------|
| Plant height(cm)         | 1.00             |                       |                            |                  |               |          |          |       |       |          |                 |           |
| Number tillers/clump     | 0.656***         | 1.00                  |                            |                  |               |          |          |       |       |          |                 |           |
| Number of leaves/tiller  | 0.437*           | 0.283 ns              | 1.00                       |                  |               |          |          |       |       |          |                 |           |
| Oil recovery (%)         | 0.493*           | 0.453*                | 0.582**                    | 1.00             |               |          |          |       |       |          |                 |           |
| Herbage yield            | 0.760***         | 0.928***              | 0.517***                   | 0.670***         | 1.00          |          |          |       |       |          |                 |           |
| Oil yield                | 0.639***         | 0.682***              | 0.621***                   | 0.955***         | 0.860***      | 1.00     |          |       |       |          |                 |           |
| Geraniol                 | -0.055 ns        | 0.132 ns              | -0.377 ns                  | -0.544 ns        | -0.025 ns     | -0.389 ns | 1.00    |       |       |          |                 |           |
| Neral                    | -0.060 ns        | 0.070 ns              | -0.346 ns                  | -0.536 ns        | -0.071 ns     | -0.401 ns | 0.993*** | 1.00  |       |          |                 |           |
| Citral                   | -0.057 ns        | 0.106 ns              | -0.365 ns                  | -0.542 ns        | -0.044 ns     | -0.395 ns | 0.999*** | 0.998*** | 1.00 |          |                 |           |
| Geraninol                | 0.044 ns         | -0.110 ns             | 0.397 ns                   | 0.517**          | 0.039 ns      | 0.378 ns | -0.996 ns | -0.995 ns | 0.998 ns | 1.00 |          |                 |           |
| Geranyl acetate          | 0.342 rs         | 0.008 rs              | 0.019 rs                   | 0.714***         | 0.177 rs      | 0.550**  | -0.518 rs | -0.488 rs | 0.507 rs | 0.451* | 1.00 |                 |           |
| G/N ratio                | 0.032 rs         | 0.029 rs              | 0.306 rs                   | 0.455*           | 0.136 rs      | 0.372 rs | -0.933 rs | -0.968 rs | -0.949 ns | 0.954*** | 0.331 ns | 1.00 |           |
CIM-Atal cultivar was mainly bred for high geraniol content purposes rather than citral content. Though, palmarosa (C. martini) crop yields comparatively less oil recovery of about (0.56%) with an average oil yield of 139.7 kg ha\(^{-1}\) comprising geraniol content of about 82.26% and geranyl acetate approximately 13.05% under the Himalayan region as reported by Chauhan et al. (2017) whereas CIM-Atal stands superior in comparison with palmarosa crop for geraniol source. This cultivar can be a substitute for geraniol-rich essential oil bearing plant in the future. Further studies are needed address its geraniol content and performance in different seasons and locations for stability.

In the present study, all cultivars met market standards of citral content, but they differ in the level of other essential oil constituents; these variations could be due to the different ratios of geranial and neral (G/N ratio) present in different cultivars of lemongrass (Table 5). G/N ratio varies from 1.32-1.84 among the eight lemongrass cultivars examined. There were no notable observations with G/N ratio of lemongrass. The G/N ratio of C. citrats from Angola is 1.43% (Soares et al., 2013), in Iran 1.26% (Avoseh et al., 2015) and whereas in Ivory Coast, it is reported about 1.33% (Sidibé et al., 2011). The essential oil of lemongrass constitutes generally has more than 45% of citral. However, the variation in citral content is observed in different species. Whereas C. citrates were reported with citral content of 30-94% being geranial as the major compound (Avoseh et al., 2015).

**Correlation of different lemongrass varieties with growth, yield and chemical parameters**

All the growth parameters of lemongrass were positively correlated with theyeld of lemongrass (Table 6). Plant height (0.760***), number of leaves per tillers (0.517***) and number of tillers/clump was highly significantly correlated with herbage yield (0.928***). The chemical parameters of lemongrass viz., geranial, neral, geraniol, geranyl acetate and G/N ratios were not significantly correlated with herbage yield of lemongrass. Whereas, a similar trend of results was noticed for oil yield except geranyl acetate (0.550**). The herbage and oil yield of lemongrass were negatively non-significant with
geranial (-0.025&-0.389), neral (-0.071&-0.401), and citral (-0.044&-0.395) respectively. Among the chemical parameter of lemongrass, geranial was highly significantly correlated with neral (0.999***) and citral (0.999*). G/N ratio was non-significant with all the parameters of the study except with oil recovery (0.455*) and geranial (0.957***). The results of the present study are in agreement with the findings of Joy et al. (2006) reported a significant positive association of morphological characters with herbage and essential oil yield of lemongrass. Verma et al. (2015) reported that G/N ratio of eight lemongrass cultivars grown in the Himalayan region varied from 1.17 to 1.76 in different seasons.

CONCLUSION

The performance of lemongrass cultivars in the southern region of Bengaluru, Karnataka, India was similar to that of lemongrass grown in different parts of India in comparison to herbage, oil yield, and quality. The cultivar CIM-Shikar recorded significantly higher amount of essential oil (302.40 kg/ha/year) with a superior market citral percentage of 84.97 ± 4.08%. CIM-Atal was superior in geranial (88.92 ± 1.00%) compared to citral content among all the cultivars studied; this cultivar may be a partial replacement/substitute for geranial rich essential oil-bearing plant in the future. Cultivating lemongrass in subtropical and similar climatic areas can offer an alternate cash crop to the farmers, which is not menaced by animals and less maintenance cost void of pests and diseases. This crop can be planted in marginal fertility soils and is also appropriate for wasteland development programmes where, crops establishment and maintenance are difficult.

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COMPLIANCE WITH ETHICAL STANDARDS

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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