The Pharma Innovation Journal 2023; 12(6): 3340-3343

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(6): 3340-3343

www.thepharmajournal.com
Received: 01-03-2023
Accepted: 07-04-2023

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Lemon and Rosa grass for sustainable agriculture development under Bundelkhand agro-climatic zone

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Abstract
The impact of climate change is evidently visible in Bundelkhand region of Madhya Pradesh. Climate change has hit the agriculture-based livelihoods and food grain production in the Bundelkhand districts has decreased by 58%. Bundelkhand is a problem region due to extremely rainfall events, prolonged dry spells, early with drawl monsoon or late commencement of monsoon, uneven rain fall distribution and at different crop growth stages. Drought condition, low rainfall, hot climate, arid and ravine lands, low quality in irrigation in term of sustainability and the availability of water resources. Defunded old water storage bodies resulted to reduction of ground water level and nondiscretionary use of water really lead to low agriculture crop productivity. All these realities were evidently showing that Bundelkhand is still facing the grave tragedy of drought. The major Kharif crops-soybean, black gram and sesame cropped area come under rainfed cultivation which was observed the failure of crops due to uncertain rainfall. While the Rabi crops like wheat, mustard and chickpea were depending up on the rain amount of Kharif due to ensure the availability of irrigation water. The soil like light, medium is the sharing 75% part which are not suitable for high value cropping as well as farming system due to low water and nutrients holding habits. The 75% farmers were under marginal, small which were not having agriculture implements and did traditional cultivation. National Innovations on Climate Resilient Agriculture (NICRA) was a network project. The project aims to enhance resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstration. The KVK (Krishi Vigyan Kendra) Tikamgarh (M.P.) was implemented the NICRA project through adaptive village -Kanti of district-Tikamgarh which situated under Bundelkhand Agro-climatic zone of Madhya Pradesh. The farmers were grown major crops failed or damaged 90-100% due to climatic hazards. There was a need for resilient practice i.e. short duration, drought resistant crops varieties, low water requirement crops, low cost cultivation and high value crop. The project of DBT was launched with convergence of IIIM, Jammu. Under the project, the lemongrass (*Cymbopogon pdendulus*) variety CPK-25 and rosagrass (*Cymbopogon khasianus*) variety CK-10 cultivation were promoted in light to medium soil of 25-farmer field as demonstrations. Two oil extortion plants were also established for oil extraction, each demonstration was conducted in one-acre area with 3-4 slips planted at one spot at a spacing of 40X 40 cm in Oct-Nov., 2020, The basal dose of 40 kg/ha phosphorus and 40 kg/ha potash were applied before the plantation. Nitrogen at the rate of 80 kg/ha were given in the split dose at sufficient moisture stage of the crop. First harvesting was taken after 145-180 days of planting i.e. June 2021. The crop yield 17-18 tone/ha herbage, 75-90 kg/of oil with net profit from Rs. 75000 to 90,000/ha in lemon grass was obtained while in rosa grass the crop yield was 50-55 tone/ha of fresh herbage with 130-180 kg/ha oil. The net profit was obtained 130,000 to 180000/ha. The less rainfall and very late monsoon in 2021 were impact the failed of major other crops cultivation in district but the farmers could have got net profit from these drought resistant grass even in extremely adverse climate. The impact on major crops and the cultivation of these grasses was found suitable for Bundelkhand climatic situation. The cultivation technology now is being popularized and horizontally spreading in the district from 25 acres to 100 acres.

Keywords: Lemongrass, rosagrass, climate change, drought

Introduction
Lemongrass distributed in Africa, Indian subcontinent, South America, Australia, Europe and North America. In India, they grow wild in all regions extending from sea level to an altitude of 4200 m. Several species were endemic to India. East Indian Lemongrass grows wild in India and cultivated well in Kerala, Assam, Maharashtra and Uttar Pradesh. It was also distributed in Guatemala and China. West Indian lemongrass believed to have originated either in Malaysia or in Sri Lanka. It was widely distributed throughout the tropics and was grown in West Indies, Guatemala, Brazil, Congo, Tanzania, India, Thailand, Bangladesh, Madagascar and China. Jammu lemongrass was mostly confined to North Indian states such as Jammu and

Kashmir, Sikkim, Assam, Bengal and Madhya Pradesh (Handa, 2001) [11]. Lemongrass was cultivated on large scale at Western Ghats of India (Nair and Jayakumar, 1999) [17]. Traditionally lemongrass was grown in high rainfall area as a rainfed crop in Kerala state. But under semi-arid tropical conditions, it was grown as irrigated crop (Singh, 1999) [24]. Lemongrass was a tropical perennial plant which yields aromatic oil. The name lemongrass was derived from the typical lemon-like odour of the essential oil present in the shoot. The herb originated in Asia and Australia. Lemongrass was one of the herbs to travel along the spice route from Asia to Europe. Lemongrass oil of commerce was popularly known as Cochin oil in the world trade, since 90% of it was shipped from Cochin port. The state of Kerala in India had the monopoly in the production and export of lemongrass oil. The annual world production of lemongrass oil was around 1000 tons from an area of 16000 ha. In India, it was cultivated in an area of 4000 ha and the annual production was around 250 t. The crop was extensively cultivated in the poor, marginal and waste lands and also along the bunds as live mulch. The well ramified root system of the plant helps in soil and water conservation. Lemongrass belongs to the family Graminae (Poaceae) and the genus *Cymbopogon*, three species *viz*. *Cymbopogon flexuosus*, *C. martinii* and *C. pendulus* were identified by (Gupta, 1969, Chandra and Narayanan, 1971, Kulkarni *et al*., 1996 and Joy *et al*., 2001) [8, 3, 15, 14].

C. flexuosus suitable for warm, humid conditions of the tropics and *C. citratus* found more drought tolerant (Weiss, 1997) [26]. In areas where rainfall was poor, it could be grown with supplemental irrigation. Day temperature of 25-30 °C considered optimum for maximum oil production, with no extremely low night temperature. Short periods above 30 °C have little general effect on plants, but severely reduce oil content. The plant hardy and resistant to draught. Maximum plant height was recorded during rainy season and least during second harvest non-rainy season. The yield of oil fluctuates greatly with the season, the condition of the plant material, its moisture content and the age of planting (Singh, 1999) [24]. The effect of seasonal changes in oil content of lemongrass was investigated during the year 1979-1980. The role of many environmental components like temperature, rainfall, relative humidity and soil moisture on the variation of oil content under the agro-climatic condition. The monsoon span was characterized by higher oil content, while the winter and autumn by comparatively lower oil content. However, the above major environmental components individually seem to have no direct relationship with the oil content. The influences exerted by the climatic factors were cumulative in exertion (Handique *et al*., 1984) [12]. Lemongrass responded to application of 100 kg N/ha under irrigated conditions and 75 to 80 kg N/ha under rainfed condition. Essential oil concentrations and quality were not affected by N-application. Lemongrass was not responding to application of P and K fertilizers or to different plant spacing under rainfed condition. Biomass and essential oil recovery was maximum during summer season harvest in all the varieties and the results were identical for two consecutive years (Rao *et al*., 1998) [20].

Lemongrass flourishes in a wide variety of soil ranging from rich loam to poor laterite. (Farooqi and Sreeramu, 2001) [5]. Although *C. flexuosus* flourishes in well drained sandy loams but in India, it was grown in almost all types of land available from very light sandy soil to upland laterites. Soils of pH 5.5 to 7.5 were utilized. *C. citratus* was more commonly grown on soils with higher acidity than C. flexuosus. In India, the highest herb and oil yields per hectare of *C. flexuosus* obtained in soils of pH 7.5. Lemongrass well grown and produce average herbage and oil yields on highly saline soils. (Weiss, 1997) [26]. It grows well on poor soils along hill slopes (Ranade, 2004) [19]. Behura *et al*., (1991) [2] have been tried to introduce in the Agro climatic conditions of India. Better growth, oil yield and oil quality and the crop might be commercially exploited in this area for diversification of crop pattern and up-liftment of rural economy (Ghosh, 1989) [7]. Lemongrass varieties released for cultivation were Sugandhi, Pragati, Praman, RRL-16, CKP-25, RRL-39, Kavery, Krishna, SD-68, GRL-1 (Farooqi and Sreeramu, 2001) [5] and SB-9 (Patra *et al*., 1999) [18]. *C. flexuosus* was propagated through seeds while *C. citratus* was propagated through division of clumps (Anon, 1981). Hussain *et al*., (1988) [13] reported that propagation through vegetative means from selected clones was considered better as seed propagation tended to cause considerable genetic heterogeneity resulting in deterioration of yield and oil quality and clonal proliferation played a very important role in the propagation of lemongrass. A spacing of 30 cm x 30 cm with a plant density of 111 000/ha is recommended. A wider spacing of 60 cm x 45 cm for seedlings and 90 cm x 60 cm for slips has been recommended for fertile, irrigated land under North Indian conditions (Farooqi *et al*., 1999). Lemongrass requires 275 kg N, 50 kg P_2O_5 and 175 kg K_2O/ha/annum. Farooqi and Sreeramu, 2001 [5].

The first harvest was generally obtained after 4 to 6 months of transplanting seedlings. Subsequent harvests were done at intervals of 60-70 days depending upon the fertility of the soil and other seasonal factors. Under normal conditions, three harvests were possible during the first year, and 3-4 in subsequent years, depending on the management practices followed. Harvesting was done with the help of sickles; the plants were cut 10 cm above ground-level and allowed to wilt in the field, before transporting to the distillation site. Depending upon soil and climatic conditions, plantation lasts on an average, for 3-4 years only. The yield of oil was less during the first year but it increases in the second year and reaches a maximum in the third year; after this, the yield declines. On an average, 25 to 30 tons of fresh herbage are harvested per hectare per annum from 4-6 cuttings, which yields about 80 kg of oil. Under irrigated conditions from newly bred varieties an oil yield of 100-150 kg/ha was obtained. The fresh herb contains on average 0.3% oil and thick stems are removed before distillation as these were devoid of oil. The grass is allowed to wilt for 24 hours before distillation as it reduces the moisture content by 30% and improves oil yield. The crop chopped into small pieces before filling in the stills. It can be distilled in same distilleries as used for Japanese mint in India. Oil was obtained through steam distillation. The oil has a strong lemon like odour. The oil yellowish in colour having 75-85% citral and small amount of other minor aroma compounds. The recovery of oil from the grass ranges from 0.5-0.8%. It taken about 4 hours for complete recovery of the oil.

Material and Methods

Bundelkhand region is largely characterized by shallow red soils, undulating topography, extreme weather conditions and recurrent droughts, making the agriculture in the region more

difficult leading to low crop productivity, crop intensity, and higher soil loss through erosion and runoff. Low moisture holding capacity of soils in the region makes it difficult to cultivate crops on residual moisture during post rainy season. This region consists of six districts of Madhya Pradesh (Datia, Tikamgarh, Chhatarpur, Damoh, Sagar and Panna) and seven districts of Uttar Pradesh (Jhansi, Jalaun, Lalitpur, Hamirpur, Mahoba, Banda and Chitrakoot) of Central India which are jointly known as Bundelkhand region. The impact of climate change is evidently visible in Bundelkhand region of Madhya Pradesh. Climate change has hit the agriculture-based livelihoods and food grain production in the Bundelkhand districts has decreased by 58%. Bundelkhand is a problem region due to extremely rainfall events, prolonged dry spells, early with drawl monsoon or late commencement of monsoon, uneven rain fall distribution and at different crop growth stages. Drought condition, low rainfall, hot climate, arid and ravine lands, low quality in irrigation in term of sustainability and the availability of water resources. Defunded old water storage bodies resulted to reduction of ground water level and nondiscretionary use of water really lead to low agriculture crop productivity. All these realities were evidently showing that Bundelkhand is still facing the grave tragedy of drought. The major Kharif crops-soybean, black gram and sesame cropped area come under rainfed cultivation which was observed the failure of crops due to uncertain rainfall. While the Rabi crops like wheat, mustard and chickpea were depending up on the rain amount of Kharif due to ensure the availability of irrigation water. The soil like light, medium is the sharing 75% part which are not suitable for high value cropping as well as farming system due to low water and nutrients holding habits. The 75% farmers were under marginal, small which were not having agriculture implements and did traditional cultivation.

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Results and Discussion

The crop yield 17-18 tone/ha herbage, 75-90 kg/of oil with net profit from Rs. 75000 to 90,000/ha in lemon grass was obtained while in rosa grass the crop yield was 50-55 tone/ha of fresh herbage with 130-180 kg/ha oil. The net profit was obtained 130,000 to 180000/ha. The less rainfall and very late monsoon in 2021 were impact the failed of major other crops cultivation in district but the farmers could have got net profit from these drought resistant grass even in extremely adverse climate. The impact on major crops and the cultivation of these grasses was found suitable for Bundelkhand climatic situation. The cultivation technology now was being popularized and horizontally spreading in the district from 25 acres to 100 acres. The findings similar to Handa, 1997 [10] who reported that harvesting done by cutting the grass 10 cm above the ground level, with the help of sickles. The number of harvests in a year depends on the climatological factors such as temperature, rainfall and humidity and level of soil fertility. Generally, the crop thrives best in humid condition Cutting can begin as soon as the nights dews have evaporated from the plants, as wet grass left for later distillation quickly ferments. Sunny days were preferable, since cloudy and misty conditions tend to depress leaf oil content. Chandra *et al*., (1970) [4] have suggested first harvest at 75 days after planting, second at 120-130 days after first harvest and the third at150-160 days after second harvest. However, Nair *et al*., (1979) [16] and Shiva (1998) [23] have suggested that first harvest can be taken at 90-days after planting and subsequent harvest at 50-55 days interval up to 5-6 years from the same crop. Rao *et al*., (2005) [21] reported five months for the citral content to reach a maximum for the first and the sixth harvest. During the first year of planting, three cuttings were obtained and subsequently 5-6 cuttings per year (Subramanyam and Gajanana, 2001) [25]. The harvesting season begins in May and continues till the end of January. An herbage yield of 10-15 t/ha/harvest may be obtained. The herb yield of lemongrass differed significantly between years. The yield in the second year was significantly higher than that of the first, third, fourth and fifth year (Singh, 2000). Gupta *et al*., (1987) [9] reported that oil content in lemongrass was 0.29% and 0.63% on fresh and dry weight basis, respectively.

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