

PERFORMANCE OF CYMBOPOGON FLEXUOSUS ON RED LATERITIC WASTELANDS OF CHHATTISGARH PLAIN AGROCLIMATIC ZONE

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Abstract

Red lateritic soil in plains of Chhattisgarh State (India), popularly known as Bhata lands (Entisols), is estimated around 20 percent area as upland, because its distribution in every village is a common topographic phenomenon. Rehabilitation of such type of degraded lands can be done by revegetation with NTFs with under storey perennial crops, not only to produce biomass for community uses but also improve the soil health. The management of such wastelands through less input and effort and meager production of appropriate biomass and commercial output in terms of oil from Lemon grass was studied at Dr Richharia Research Farm of Indira Gandhi Krishi Vishwavidyalaya, Baronda, Raipur. *Cymbopogon flexuosus* was cultivated in rainfed condition as sole crop on Bhata soil with application of 30 kg N, 20 kg P & K comprising eight different treatments [T₁- N₀P₀K₀, T₂- N₃₀P₀K₀, T₃- N₀P₂₀K₀, T₄- N₀P₀K₂₀, T₅- N₃₀P₂₀K₀, T₆- N₃₀P₀K₂₀, T₇- N₀P₂₀K₂₀ and T₈- N₃₀P₂₀K₂₀] under split plot design having three replications in years 2007 & 2008. Production of Lemon grass was taken by three cut in September, December and February in a year. Application of NPK gave positive results of production performance. However the different combination of NPK (30 kg N, 20 kg P & K) showed the application of N+K was more effective as compared to N+P and P+K. Effect of fertilizers on production of *C. flexuosus* were observed in order of T₈ > T₆ > T₅ > T₇ > T₂ > T₄ > T₃ > T₁ in all the three harvestings during both the cropping years with statistically significant variations.

Keywords: Red Lateritic soil; Entisols; Bhata soil; Waste land; Aromatic plants; *Cymbopogon flexuosus*; Fertilizer; Biomass & etc.

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1. Introduction

The Chhattisgarh has about 44 per cent area under forest with greater level of biodiversity among flora particularly medicinal and aromatic plants available in the state due to which Chhattisgarh now has been declared as herbal state. But the unscientific collection of herbal plants like Kalihari, Guggule, Lemon grass, Musli, Kalihaldi, Kewanch and many more species are threatened due to illegal and over exploitation. These valuable medicinal and aromatic herbs are getting exhausted very fast due to increasing demand by the pharmaceutical industries and illegal export also. To keep balance between production and demand it is necessary that the cultivation of medicinal and aromatic plant species in farmer field is needed to be exploited at large scale (Thakur and Dutt, 2007). Cultivation of

commercially valuable medicinal and aromatic plants will immensely increase employment potential throughout the year and it will also be effective to increase total production area.

In Chhattisgarh State (India), Red lateritic soil popularly known as Bhata lands (*Entisols*), is very common feature and as an estimate it to be around 20 per cent of total area in central plains of Chhattisgarh (Naugraiya *et al.* 2005). Rehabilitation of such type of degraded lands can be done by re-vegetation with multipurpose trees/woody species/perennial plants (Naugraiya and Puri, 1997). Looking to the above facts and figures, the choice of species plays a key role in such degraded land; hence, suitable species should be grown to produce biomass for community uses and also improvement of the soil health.

Lemon grass scientifically known as *Cymbopogon flexuosus*, belongs to the family Poaceae (Pillay, 1961). The strong lemon like odour due to this characteristics smell, the oil is extensively used for scenting soap, detergents and an array of other products. The essential oil of Lemon grass having its chief constitutes citral is used in perfumery and flavouring industries as well as in synthesis of vitamin A, and aromatherapy (Rande 1959). Hence, looking to the importance of *Cymbopogon flexuosus* as a high value crops the present investigation was undertaken in the *Entisols* of Chhattisgarh.

2. Research Method

The present study was conducted in *Entisols* (Bhata Land) for two years of cropping seasons *i.e.* 2007-2009 at Dr. Richharia Research and Instructional Farm Baronda, Department of Forestry, IGKV, Raipur (CG). The study site falls under the central region of Chhattisgarh plains agro-climatic zone. *Cymbopogon flexuosus* was planted at spacing of 1x 1 m with treatments considered eight different combination of NPK fertilizer @ 0, 20, 30 kg/ha comprises of following 8 treatments - (NOPOKO, N3OPOKO, NOP2OKO, NOPOK2O, N3OP2OKO, N3OPOK2O, NOP2OK2O and N3OP2OK2O) in July 2007. Fertilizers was applied in two split doses during planting *i.e.* July/Aug and followed by 45 days after planting (second dose). Nitrogen in form of Urea, Phosphorus in form of SSP and Potash at the rate of 30 kg N/ha, 20 kg P/ha, and 20 kg K/ha. Disease free and healthy rooted slips of *C. flexuosus* was transplanted at a distance of one meter spacing in both as intercrop ps as well as sole crops and given light irrigation.

The crop was harvested three times or cropping season during two consequent years. The first harvest was done at 75 day after planting (September), second harvesting was done 90 day after first harvesting (December) and third or final harvesting was done in February *i.e.*, 75 day after second harvesting. Harvested plants of Lemon grass of each treatment were used for determination of oil content with the help of Clevenger apparatus hydrodistillation method. The oil content was

determined in consequence three growth periods *i.e.*, September, December and February month in both the cropping year *i.e.*, 2007-08 and 2008-09. The tree growth characteristics viz., Height, CD, DBH, Crown width and Crown length were measured with the standard methods (Chaturvedi and Khanna, 1982).

The climate of study site is dry humid sub-tropical with an average annual rainfall of 1250 mm. About 80 percent of the annual rainfall is received from south- west monsoon during June to mid August. The mean monthly minimum temperature varies from 13.2⁰C in December to 28.3⁰C in May with maximum temperature goes beyond 45⁰C in May and minimum below 10⁰C in December. The relative humidity lies between 70-90 per cent from mid June to March end.

Bastar region is located in the southern part of Chhattisgarh state and situated at a height of 2000 ft plateau from sea level. The borders of Bastar region are Maharashtra State in the north & west, in the south & east touch Orissa State. The beauty of Bastar region lies in its natural forest area and various types of tribals. The total forest area is more than 75 % of the total area of the region. The district has an average population of 1,411,644 as per the 2011 census. Of the total population 86 % are rural population in which more than 70 per cent are tribal people like Gond, Dandavi Maria, Bison Horn Maria, Muria Dorla, Dhruva, Bhatra and Halba Tribe, etc. The forest villages are placed in mountainous and highly sloped areas where agricultural activities have many limitations. This fact increases the usage of the forest resources and makes the life difficult in the forest villages.

The original data about the NTFPs was obtained from questionnaires applied to villages using face to face interviews method in the ten villages of five blocks *i.e.*, Jagdalpur, Darbha, Bastar, Bakawand and Tokapal in Bastar district and also from the local (Haat, Bazaar) market survey. The questionnaire comprised both close-ended and open-ended questions about food, treatment, usage reason, used plants, income, education, etc. The present study was made to gather information about species with high demand, their status and uses in that area, so that a sight can be put for these valuable lives giving plant for their conservation and sustainable harvesting.

3. Results and Analysis

Production performance of Lemon grass (*Cymbopogon flexuosus*)

In the present investigation, the production performance were recorded for herbage, dry matter, oil production and oil content of *C. flexuosus* and compared as sole and intercrop with *D. sissoo*. The effect of different available resources utilization under rainfed condition of red lateritic land was discussed in following heads.

Effect of cropping season: The number of harvests in a year depends on the climatic factors such as temperature, rainfall and humidity and level of soil fertility as well as cultivation and management practices. The maximum herbage (209.24 q ha⁻¹), dry matter (56.69 q ha⁻¹) and oil (76.68 kg ha⁻¹)

production of *C. flexuosus* was observed in first harvest (September) of first cropping years and it was found similar trend in second year (Table-1 & 2). First cropping season (September) has moderate PAR and temperature with high relative coupled with suitable soil moisture resulting high rate of photosynthesis in the plants particularly C_4 plant species (Beech, 1977). Growth and production of herbs and oil was found in decreasing order during second (December) and third (February) cropping season because the relative humidity and soil moisture was found to be consistently decreasing. Both immature and over mature crops give low yield and oil of poor quality (Farroqi and Sreeramu, 2001). Oil content was slightly less in first and second harvests than third harvest, which may be due to the rainy season. In case of decline in herbage, dry matter and oil production of *C. flexuosus* with intercropping of tree might be due to decreased the vital activities of plant with increasing the comparative dryness in climate as well as in plants (Duriyprapan and Britton, 1982) in red lateritic soil another reason for significant reduction in herb yield might be attributed to the lower fertility status build-up in root zone during the second and third cropping seasons.

Overall oil content was extracted higher in summer season *i.e.*, harvest in February which is initial stage of summer days in Chhattisgarh. Rao *et al.* (1998) and Gupta *et al.* (1978) found that the similar result, the oil content in Lemon grass was more in summer. This may be because in summer plants may be expected to contain less moisture and therefore more oil on fresh weight basis. The effect of cropping season in a year for more than one harvest could be explained on the basis of spectral composition and light intensity on cell structures which are the site of oil formation. Light favours the formation of oil and stimulates the bio-chemical and physiological reactions during the biosynthesis of oil (Singh M., 2001).

Fertilizer significantly increased the fresh and dry herbs yield of plants compared to the control treatment (Table 1 & 2). In the first cropping season the dry herbs increased over control by N, NP, NK and NPK doses of fertilizer. The corresponding increases in dry herbs yield at second year 1.47, 1.32 and 1.44 times respectively for 1st, 2nd and 3rd cropping season. Nitrogen uptake increased significantly with all the fertilizer as compared with control during three seasons. Similar results had been reported by Ram *et al.* (1989) on Japanese mint, Singh and Singh (1992) on Citronella grass.

Effect of fertilizer: Effect of fertilizer on the total biomass (Fresh & Dry) and oil production of Lemon grass was found significant. It was highest (155.94, 50.12 q ha⁻¹ fresh & dry matter) in T₈ (N₃₀P₂₀K₂₀) followed by T₆ (N₃₀P₀K₂₀), T₅ (N₃₀P₂₀K₀), T₇ (N₀P₂₀K₂₀) and lowest (35.68, 16.98 q ha⁻¹ fresh & dry matter) in T₀ (N₀P₀K₀) during 1st year and followed similar pattern in 2nd year, however nitrogen is an important nutrient but presence of potassium played an important role for enhancing the yield of herbs and oil, it means application of NPK gave positive results for production performance (Table-1). However the different combination of NPK (30 kg N, 20 kg P & K) showed that application of NPK as individual fertilizer did not found effective as compare to combination of two fertilizers and all three fertilizers in red lateritic soil. The combined application of N and K was more effective as

compare to N & P and P & K. Parbery *et al.* (1968) reported that apart from N the K is also necessary for higher production of Lemon grass in their study of nutrient uptake and removal from the soil. Similar observations were also reported by Beech (1977). Maheshwari *et al.* (1984) reported appreciable increases in the yields of Lemon grass on application of nitrogenous fertilizers. Dhahotonde and Fasate (1988) reported that application of N with P had no effect on quantity and quality of Lemon grass oil. Singh *et al.* (1997) on *Coriandrum sativum*. Satyabrata Maiti (2004) reported that higher doses N produced significantly higher herbage and oil yield over control. Prasad and Mukharjee (1980) recommended 40 kg N/ha and 40 kg P₂O₅/ha for higher yields of Lemon grass. Yadava, (1999 & 2000) reported the herbage yield of Lemon grass was significantly affected by change in spacing and application of fertilizer doses, as compared to control.

Table: 1 Production performance of *C. flexuosus* under agroforestry system in cropping season 2007-08

Treatment	Season I				Season II				Season III			
	Herbage prod (q ha ⁻¹)	Dry matter (q ha ⁻¹)	Oil prod (kg ha ⁻¹)	Oil content (%)	Herbage prod (q ha ⁻¹)	Dry matter (q ha ⁻¹)	Oil prod (kg ha ⁻¹)	Oil content (%)	Herbage prod (q ha ⁻¹)	Dry matter (q ha ⁻¹)	Oil prod (kg ha ⁻¹)	Oil content (%)
T ₁ - N ₀ P ₀ K ₀	112.03	27.04	38.23	0.344	110.52	15.80	31.34	0.273	35.68	16.98	13.10	0.324
T ₂ - N ₃₀ P ₀ K ₀	132.80	35.95	48.19	0.357	117.38	29.91	37.62	0.322	52.04	20.27	21.39	0.387
T ₃ - N ₀ P ₂₀ K ₀	119.54	28.68	42.05	0.349	113.95	20.25	33.81	0.296	44.53	18.29	17.20	0.343
T ₄ - N ₀ P ₀ K ₂₀	129.58	33.99	46.05	0.351	114.30	25.49	34.41	0.304	49.93	19.08	19.93	0.351
T ₅ - N ₃₀ P ₂₀ K ₀	142.76	39.98	52.51	0.365	121.61	40.62	43.90	0.356	62.94	22.19	26.66	0.405
T ₆ - N ₃₀ P ₀ K ₂₀	153.97	41.85	56.94	0.367	125.48	43.83	50.73	0.389	67.86	24.29	29.37	0.425
T ₇ - N ₀ P ₂₀ K ₂₀	135.42	37.91	49.40	0.362	119.41	30.52	40.71	0.339	58.21	20.79	24.07	0.395
T ₈ - N ₃₀ P ₂₀ K ₂₀	155.94	50.12	59.24	0.373	127.78	48.70	54.01	0.410	74.24	27.78	32.30	0.431
SEm ±	6.03	2.12	2.32	0.001	3.33	2.78	2.26	0.016	1.44	1.52	0.80	0.012
CD (at 5%)	17.46	6.13	6.70	0.005	9.63	6.59	6.55	0.045	4.18	5.13	2.42	0.036

Table: 2 Production performance of *C. flexuosus* under agroforestry system in cropping season 2008-09

Treatment	Season I				Season II				Season III			
	Herbage prod (q ha ⁻¹)	Dry matter (q ha ⁻¹)	Oil prod (kg ha ⁻¹)	Oil content (%)	Herbage prod (q ha ⁻¹)	Dry matter (q ha ⁻¹)	Oil prod (kg ha ⁻¹)	Oil content (%)	Herbage prod (q ha ⁻¹)	Dry matter (q ha ⁻¹)	Oil prod (kg ha ⁻¹)	Oil content (%)
T ₁ - N ₀ P ₀ K ₀	138.16	36.05	48.40	0.345	124.35	29.96	50.07	0.399	85.49	25.55	36.75	0.424
T ₂ - N ₃₀ P ₀ K ₀	163.33	53.20	59.19	0.356	135.13	41.31	56.16	0.410	96.55	32.05	40.87	0.425
T ₃ - N ₀ P ₂₀ K ₀	145.09	38.19	51.39	0.351	131.96	38.04	54.31	0.407	90.15	29.75	38.87	0.428
T ₄ - N ₀ P ₀ K ₂₀	160.48	50.76	57.51	0.353	131.86	40.94	54.79	0.408	93.22	30.50	40.18	0.429
T ₅ - N ₃₀ P ₂₀ K ₀	168.70	59.13	61.89	0.363	136.83	43.92	57.14	0.414	99.05	34.82	43.69	0.436
T ₆ - N ₃₀ P ₀ K ₂₀	176.42	59.70	65.19	0.366	144.36	48.36	61.91	0.422	99.33	36.16	43.81	0.437
T ₇ - N ₀ P ₂₀ K ₂₀	167.15	56.17	60.79	0.360	136.29	41.61	57.63	0.416	98.15	33.08	43.46	0.438
T ₈ - N ₃₀ P ₂₀ K ₂₀	179.83	71.44	67.63	0.371	145.44	64.52	62.95	0.427	103.85	40.24	46.96	0.446
SEM ±	10.44	2.40	3.74	0.001	2.76	4.08	1.17	0.001	1.44	1.48	0.63	0.001
CD (at 5%)	NS	6.96	10.84	0.003	7.73	11.81	3.39	0.003	4.18	5.34	1.98	0.003

Table 3: Physical and chemical status of soil during 1st year (2007-08) of cropping season

Treatment	WHC (%)	pH	Org. C (%)	Available N (Kg/ha)	Available P (Kg/ha)	Available K (Kg/ha)
T ₁ - N ₀ P ₀ K ₀	30.30	5.50	0.37	123.85	8.72	62.36
T ₂ - N ₃₀ P ₀ K ₀	38.95	5.53	0.43	163.51	8.59	63.48
T ₃ - N ₀ P ₂₀ K ₀	34.20	5.69	0.48	137.55	12.81	70.41
T ₄ - N ₀ P ₀ K ₂₀	52.08	5.92	0.60	149.07	11.12	85.32
T ₅ - N ₃₀ P ₂₀ K ₀	36.70	6.52	0.66	170.61	15.25	77.77
T ₆ - N ₃₀ P ₀ K ₂₀	42.53	6.27	0.64	173.88	15.47	92.07
T ₇ - N ₀ P ₂₀ K ₂₀	47.08	6.42	0.64	161.76	19.16	99.58

T ₈ - N ₃₀ P ₂₀ K ₂₀	45.29	6.34	0.82	181.62	19.39	105.17
SEm ±	1.53	0.30	0.04	1.83	1.01	1.34
CD (at 5%)	3.91	NS	0.10	5.29	2.95	3.89

Table 4: Physical and chemical status of soil during 2nd year (2008-09) of cropping season

Treatment	WHC (%)	pH	Org. C (%)	Available N (Kg/ha)	Available P (Kg/ha)	Available K (Kg/ha)
T ₁ - N ₀ P ₀ K ₀	29.23	5.30	0.55	149.52	12.05	77.09
T ₂ - N ₃₀ P ₀ K ₀	38.00	5.42	0.57	172.65	13.95	83.78
T ₃ - N ₀ P ₂₀ K ₀	32.38	5.55	0.60	156.28	16.36	97.25
T ₄ - N ₀ P ₀ K ₂₀	48.88	5.66	0.78	162.75	14.44	107.80
T ₅ - N ₃₀ P ₂₀ K ₀	35.00	6.00	0.73	175.03	18.64	101.21
T ₆ - N ₃₀ P ₀ K ₂₀	44.88	5.72	0.84	182.00	17.75	116.36
T ₇ - N ₀ P ₂₀ K ₂₀	46.99	5.88	0.78	168.67	19.96	119.94
T ₈ - N ₃₀ P ₂₀ K ₂₀	42.16	5.77	0.96	188.02	21.11	129.35
SEm ±	0.42	0.16	0.02	1.16	1.07	1.24
CD (at 5%)	1.21	NS	0.05	3.36	3.10	3.57

4. Conclusion

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