

Original Research Article

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Growth Parameters and Herbage Yield of Java Citronella as Influenced by Nutrient Management under Inceptisol

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ABSTRACT

The field study was carried out during *kharif* 2009-10 and 2010-11. The fertility status of the soil was moderate in organic carbon, low in available N and P and very high in available K while the soil micronutrient contents (Zn, Fe, Mn, Cu) were above the critical level. Experiment comprised of thirteen treatments replicated thrice in randomized block design, involving control (no fertilizer/manure), 5 t FYM ha⁻¹, 10 t FYM ha⁻¹, 80:20:40 kg NPK ha⁻¹, 100:30:60 kg NPK ha⁻¹, 140:40:80 kg NPK ha⁻¹, 5 t FYM + 80:20:40 kg NPK ha⁻¹, 5 t FYM + 100:30:60 kg NPK ha⁻¹, 5 t FYM + 140:40:80 kg NPK ha⁻¹, 10 t FYM + 80:20:40 kg NPK ha⁻¹, 10 t FYM + 100:30:60 kg NPK ha⁻¹, 10 t FYM + 140:40:80 kg NPK ha⁻¹ and 100 kg N through FYM (based on FYM analysis). The results from the experimentation indicated that, the combined application of FYM + NPK @ 10 t + 140:40:80 kg ha⁻¹ resulted in maximum plant height (140.20 cm) and number of tillers (58.43) followed by 5 t FYM + 140:40:80 kg NPK ha⁻¹ which was significantly superior over rest of the treatments. Herbage yield was comparatively higher during the second year of the crop and it was increased successively with each combination of increasing FYM levels and graded doses of NPK. Significantly highest herbage yield was recorded with 10 t FYM along with 140:40:80 kg NPK ha⁻¹. From the results, it can be concluded that the conjunctive use of FYM along with chemical fertilizer (10 t FYM + 140:40:80 kg NPK ha⁻¹) was found beneficial way of nutrient management to increase the plant height, number of tillers and herbage yield of Java citronella.

Keywords

Java citronella, Nutrient management, Plant height, Number of tillers, Herbage yield

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Introduction

In India and particularly in Maharashtra the dry land agriculture has prime role in food crop production. However, the undependable

and erratic rainfall in the region introduces an element of risk, uncertainty and instability in crop production, which resulting into financial deterioration of rural farming sector. Farming community is in search of non-

traditional cropping systems, suitable for dryland agriculture, indicating the diversification in agriculture, however, the selection of the crop for diversification should be based on their adaptability and economic returns. Changing the pattern of commercial crops has become an ecological need however, it is necessary that the introduction of new crops should be economically viable in a particular region.

Cymbopogon winterianus commonly known as Java citronella belongs to Graminae family and is originally from Sri Lanka was selected for the study. It is a tall perennial tufted aromatic grass with superficial fibrous roots. It is basically, a tropical plant mainly cultivated in Indonesia, Sri Lanka, China and India. In India, major producing area is the tea gardens in Assam and to a limited extent in states like U.P., Maharashtra, Karnataka, Gujarat, Manipur, Meghalaya, Tamil Nadu, Nagaland, Uttaranchal, A.P. and Tripura where it is commercially cultivated and distilled for its oil (Shiva *et al.*, 2002).

The oil is used mostly in perfumery, both directly and indirectly in soaps, soap flakes, cosmetics, detergents, agarbatties, insecticides, *etc.* are often perfumed exclusively with this oil. Small quantity of citronellal is used in perfumery as an aromatic chemical. However, the greatest importance of citronellal lies in its role as a starting material for further derivatives. It is good mosquito repellent. The leftover of the citronella grass has been recommended to be utilized as source of raw material for cellulose pulp and paper production by using sulphate, sulphite and cold caustic soda.

Java citronella accumulates the biomass and nutrients very rapidly only after five months of planting and the biomass production and nutrient uptake was found to be highest after ten months of plant growth. The

concentrations of N, P and K did not fluctuate much throughout year (Prakasa Rao and Ganesha Rao, 1986).

At present no information is available on nutrient management of these grasses under agroclimatic condition of Vidarbha region of Maharashtra. Being a perennial crop periodic replenishment of nutrients is essential to keep the plantation viable for 4-5 years. Therefore, keeping in view of above facts the present investigation was carried out.

Materials and Methods

Study site and treatment details

The field experiment was conducted during *Kharif* seasons of 2009-10 and 2010-11 at Nagarjun Medicinal Plants Garden, Dr. PDKV, Akola (latitude of 22° 41' N and longitude of 77° 02' E with an altitude 307.41 meters). The climate of experimental site is semi-arid and subtropical with extreme conditions having hot and dry summer and cold winter, where maximum temperature goes up to 42.6°C during summer and minimum as low as 10.3°C during winter. The annual average rainfall of area is 764.7 mm. The soil of the experimental field was medium black, Smectitic, clay loam in texture and classified as *Typic Haplustept* which comes under the soil order Inceptisol. The initial soil analysis indicated that, the soil was calcareous in nature and moderately alkaline in reaction. In case of physical properties the soil was low in hydraulic conductivity and available water capacity. The fertility status of the soil was moderate in organic carbon, low in available nitrogen and available phosphorus and very high in available potassium while the soil micronutrient contents (Zn, Fe, Mn, Cu) were above the critical level. The experiment was laid out with randomized block design having three replication comprising of 13 treatments, *viz*

Control (no fertilizer/manure), 5 t FYM ha⁻¹, 10 t FYM ha⁻¹, 80:20:40 kg NPK ha⁻¹, 100:30:60 kg NPK ha⁻¹, 140:40:80 kg NPK ha⁻¹, 5 t FYM + 80:20:40 kg NPK ha⁻¹, 5 t FYM + 100:30:60 kg NPK ha⁻¹, 5 t FYM + 140:40:80 kg NPK ha⁻¹, 10 t FYM + 80:20:40 kg NPK ha⁻¹, 10 t FYM + 100:30:60 kg NPK ha⁻¹, 10 t FYM + 140:40:80 kg NPK ha⁻¹ and 100 kg N through FYM (based on FYM analysis). Treatment wise FYM was added on dry weight basis before planting of Java citronella during 2009-10 contain 0.67% N, 0.22% P and 0.49% K and in the month of April 2010 contain 0.64% N, 0.20% P and 0.51% K after 3rd cutting as per treatments. Treatment wise Nitrogen, Phosphorus and Potassium doses were applied in both the years (2009-10 and 2010-11). Nitrogen was applied through urea in three split doses as per treatment after each cutting. Full dose of Phosphorus and Potassium was applied as a basal dose at the time of planting through single super phosphate and muriate of potash as per the treatments.

Sowing and harvesting

The study started on 7th July 2009, when Java citronella 'Bio-13' plantlets were planted (rooted slips @ 16666 slips ha⁻¹). A spacing of 90 x 60 cm was maintained between each planting. The plantlets were irrigated soon after transplantation and thereafter as and when needed during the experiment. Java citronella was harvested by cutting the leaf blade at its base, i.e., approximately 10-12 cm above the ground. During the two seasons of the study, the crop was harvested 6 times.

Growth contributing parameters and Herbage yield

The ten plants were selected randomly from each treatment per plot for recording yield contributing parameters. The plant height and number of tillers was recorded at every

cutting and average height and average number of tillers was recorded. The fresh weight of Java citronella grass was recorded treatment wise at each cutting and computed for herbage yield per hectare by multiplying hectare factor.

Statistical analysis

Standard method of analysis known as 'Analysis of Variance' was applied for the statistical analysis. The critical difference (C.D.) was worked out at 5% level of significance for the treatment comparison wherever the 'F' test recorded significant. Pooled analysis of two years data was carried out as per procedure described by Gomez and Gomez (1984).

Results and Discussion

Plant height

The data pertaining to plant height of Java citronella as influenced by different treatments of nutrient management during 2009-10 and 2010-11 are presented in table 1. The wide variation in plant height was noticed due to different treatment application and the plant height was in the range of 47.13 - 140.65 cm. comparatively more plant height was observed during the second year study.

Effect of organic manure (FYM)

The application of organic manure (FYM) at different doses significantly increased the plant height during both the years. It is observed that the plant height was found to increase with each dose of FYM and significantly highest plant height was recorded with the application of 10 t FYM ha⁻¹ (T₃) as compared to control (T₁). However, it was at par with the application of 5 t FYM ha⁻¹ (T₂). Similar observations have also been made by Pareek *et al.*, (1983) and

Anonymous (1998). Further, the data showed that the application of 100 kg nitrogen through FYM dose on the basis of nitrogen analysis (T_{13}) recorded comparatively more plant height than the plant height recorded with 10 t FYM ha^{-1} (T_3) however it was at par with the treatment. The study by Maheshwari *et al.*, (1991^a) also reported increased in plant height of rainfed Palmarosa with the application of FYM @ 15 t ha^{-1} as compared to control under Vertisol.

Effect of NPK fertilizer

The application of NPK fertilizer doses significantly increased the plant height as compared to alone application of FYM doses. Anonymous (1987^d) reported increased in plant height with nitrogen application than FYM alone. Further, the plant height was found to increase with each addition of NPK dose and significantly highest plant height was recorded with the application of 140:40:80 kg NPK ha^{-1} (T_6) however, the significant effect was noticed during first year and the pooled data also. Increased in plant height with the nitrogen application reported by Prakasa Rao *et al.*, (1983), Singh and Singh (1998) and Anonymous (2012) with the phosphorus and potassium application Sukhmal Chand and Rajeswara Rao (1996), and nitrogen, phosphorus application Pareek *et al.*, (1981^b) and Wankhade *et al.*, (2010).

Combined effect

The data presented in table 1 further revealed that the plant height was found to increased with the application of FYM doses along with graded doses of NPK fertilizer. It is also noticed that the plant height was successively increased with the application of FYM along with graded doses of NPK and significantly highest plant height was recorded with treatment T_{12} i.e. application of 10 t FYM + 140:40:80 kg NPK ha^{-1} . The treatment effect

was found significant during first year and in pooled means. Although, the maximum plant height was recorded with treatment T_{12} (10 t FYM + 140:40:80 kg NPK ha^{-1}) followed by treatment T_9 (5 t FYM + 140:40:80 kg NPK ha^{-1}), the treatment differences of combination doses were statistically at par. The results are confirmed with the findings of Maheshwari *et al.*, (1993) and Sukhmal Chand *et al.*, (1996).

From the pooled data (table 1) it is observed that among the treatments comprised of FYM doses, the FYM treatment equivalent to 100 kg N ha^{-1} recorded significantly maximum plant height (77.76 cm) as compared to T_2 (FYM @ 5 t ha^{-1}) and T_1 (control), however, it was found at par with treatment T_3 (FYM @ 10 t ha^{-1}). The data further showed that the plant height was markedly increased with the application of graded doses of NPK and significantly maximum plant height (125.46 cm) was observed with the application of 140:40:80 kg NPK ha^{-1} (T_6). The combined application of FYM + NPK @ 10 t FYM + 140:40:80 kg NPK ha^{-1} (T_{12}) resulted in significantly maximum plant height (140.20 cm), which was significantly superior over all other treatments except, T_9 (5 t FYM + 140:40:80 kg NPK ha^{-1}).

Number of tillers

The data on number of tillers during 2009-10 and 2010-11 as influenced by various treatments of nutrient management are presented in table 1. From the data it was seen that the number of tillers was successively increased with every cutting during the two years of experimentation.

Effect of organic manure (FYM)

It is evident from the data that, amongst FYM application treatments, the application of 100 kg N through FYM (T_{13}) to Java citronella

recorded the significantly higher number of tillers as compared to treatment T₂ (FYM @ 5 t ha⁻¹) and T₁ (control). However, the treatment T₁₃ was found at par with treatment T₃ (FYM @ 10 t ha⁻¹) during the first year, whereas, in the second year of crop the treatment T₁₃ was statistically significant over all the other FYM treatments (i.e. T₂ and T₃) and control (T₁). Increased availability of water and nutrients could be responsible for these results.

Effect of NPK fertilizer

Alone application of NPK graded dose treatment T₆ (140:40:80 kg NPK ha⁻¹) recorded the significant highest number of tillers during both the years as compared to other NPK fertilizer doses treatments viz. T₄ (80:20:40 kg NPK ha⁻¹) and T₅ (100:30:60 kg NPK ha⁻¹) and T₁ (control). Formation of plant parts above the soil represent photosynthesis apparatus in conversion of solar energy in to chemical energy totally depends on the utilization of carbohydrates and other metabolites in roots accelerated by nitrogen uptake which ultimately gives more number of tillers. Phosphorus having close relationship in cell division and development, it stimulates early root development and growth. So, it might be the reason to improve tiller number due to increased application of phosphorus. These results were supported by Prakasa Rao *et al.*, (1983), Singh and Singh (1998) and Wankhade *et al.*, (2010).

Further, it is observed that the number of tillers were significantly more with the NPK treatments than FYM alone application. Similar result was reported by Anonymous (1987^d).

Combined effect

The data further revealed that, the combined application of FYM with NPK recorded the

significantly maximum number of tillers with the treatment T₁₂ (FYM @ 10 t + NPK @ 140:40:80 kg ha⁻¹) over rest of the all other combination treatments (T₇ to T₁₁), NPK fertilizer treatments (T₄, T₅ and T₆), FYM treatments (T₂, T₃, and T₁₃) and control (T₁) during both the years of experimentation. This might be due to better and balanced availability of nutrients, resulted in highest uptake of the nutrients by the plant which ultimately resulted in highest number of tillers.

The beneficial effect of FYM along with N, NP and NPK on number of tillers of the plant was earlier reported by many workers (Sharma *et al.*, 1980, Maheshwari *et al.*, 1993, Sukhmal Chand *et al.*, 1996 and Anonymous, 2009).

The pooled analysis data of two years indicated that, among the different FYM treatments, treatment T₁₃ i.e. 100 kg N through FYM recorded significant higher number of tillers (40.46) as compared to other FYM treatments (T₂ and T₃) and T₁ (control). Comparatively higher number of tillers (46.64) was recorded with the application of NPK @ 140:40:80 kg ha⁻¹ (T₆) than other NPK treatments (T₄ and T₅) and T₁ (control).

Among the combination treatments, the treatment of FYM @ 10 t along with NPK @ 140:40:80 kg ha⁻¹ (T₁₂) recorded the significantly higher number of tillers (58.43) over all the other treatments under study.

Herbage yield

The data regarding herbage yield of Java citronella as influenced by various treatments of nutrient management are presented in table 2. The data showed that the herbage yield was comparatively higher during the second year of the crop.

Effect of organic manure (FYM)

The application of FYM significantly increased the herbage yield as compared to control, further, it is noticed that the herbage yield was found to increase with each addition of FYM dose and significantly highest herbage yield was recorded with the application of 10 t FYM ha⁻¹ among the FYM treatments. The application of FYM dose equivalent to 100 kg N ha⁻¹ produced comparatively higher herbage yield than application of 10 t FYM ha⁻¹ (T₃), however, the significant increase due to the treatment was noticed during second year and pooled means.

The application of higher dose of FYM (T₁₃) to the crops which resulted in the better crop growth and ultimately resulted in higher herbage yield. Pareek *et al.*, (1983) revealed that application of FYM @ 10 t ha⁻¹ showed a beneficial effect on plant height, number of tillers and herbage yield of Palmarosa grown on sandy loam soils. The increase was 42.6 per cent more than no FYM application. The beneficial effect of FYM on physico-chemical and biological properties of the soil resulted in solubilization of nutrients in the soil and thereby increased the availability to the plants, ultimately resulted in increased herbage yield.

Effect of NPK fertilizer

The application of graded doses of NPK also significantly increased the herbage yield during both the years, further, it is observed that the herbage yield was successively increased with the every increment of graded dose of NPK significantly highest herbage yield was recorded with the application of 140:40:80 kg NPK ha⁻¹ (T₆) as compared to the treatment T₄ (80:20:40 kg NPK ha⁻¹) and T₅ (100:30:60 kg NPK ha⁻¹). Further, it is noticed that the herbage yield produced due to

the application of various graded doses of NPK fertilizer significantly higher herbage yield as compared to the herbage yield produced with the alone application of FYM doses. Due to the application of chemical fertilizers (NPK) the nutrients availability in the soil solution might have increased which resulted in the higher content and uptake of nutrients and ultimately better growth and higher herbage yield.

Several workers have reported the beneficial effect of chemical fertilizers on the herbage yield of Java citronella grown under various soil types and climatic conditions (Dutta and Mishra, 1973, Ghosh and Chatterjee, 1978, Virmani *et al.*, 1979, Singh, 1988 and Nandi and Chatterjee, 1997).

Combined effect

The data presented in table 2 revealed that the combined application of organic manure (FYM) and chemical fertilizer (NPK) at various doses further enhanced the herbage yield during both the years. The herbage yield was found to increase successively with each combination of FYM doses and graded doses of NPK. Significantly highest herbage yield was produced with the application of 10 t FYM along with 140:40:80 kg NPK ha⁻¹ (T₁₂) during both the years under study.

The combined application of organic manure along with chemical fertilizer have favorable effect on the nutrient availability to the crop as well as on the soil properties which might have resulted in better growth and ultimately the higher herbage yield. The results are in agreement with Sharma *et al.*, (1980), Maheshwari *et al.*, (1993), Sukhmal Chand *et al.*, (1996), Anwar *et al.*, (2005), Anonymous (2009), Verma (2010) and Singh *et al.*, (2011).

Table.1 Plant height and number of tillers of Java citronella as influenced by different treatments of nutrient management

Treatments	Average Plant height (cm)*			Average Number of tillers*		
	2009-10	2010-11	Pooled mean	2009-10	2010-11	Pooled mean
T ₁ – Control	50.83	47.13	48.98	19.78	28.80	24.29
Organic manure doses (t ha⁻¹)						
T ₂ - 5 t FYM ha ⁻¹	63.54	70.16	66.85	26.27	35.61	30.94
T ₃ - 10 t FYM ha ⁻¹	67.19	77.82	72.50	30.71	43.16	36.93
NPK fertilizer doses (kg ha⁻¹)						
T ₄ - 80:20:40 kg NPK ha ⁻¹	102.00	110.00	106.00	34.20	45.18	39.69
T ₅ - 100:30:60 kg NPK ha ⁻¹	110.56	119.02	114.79	37.02	47.57	42.29
T ₆ - 140:40:80 kg NPK ha ⁻¹	122.60	128.31	125.46	41.24	52.04	46.64
Combined doses (O. M. + NPK fertilizer)						
T ₇ - 5 t FYM + 80:20:40 kg NPK ha ⁻¹	111.45	123.86	117.66	36.71	48.20	42.45
T ₈ - 5 t FYM + 100:30:60 kg NPK ha ⁻¹	118.72	130.47	124.59	39.46	50.37	44.92
T ₉ - 5 t FYM + 140:40:80 kg NPK ha ⁻¹	131.42	137.34	134.38	45.76	57.11	51.44
T ₁₀ -10 t FYM + 80:20:40 kg NPK ha ⁻¹	122.63	132.35	127.49	38.94	51.99	45.47
T ₁₁ -10 t FYM + 100:30:60 kg NPK ha ⁻¹	128.05	134.26	131.15	43.17	56.12	49.64
T ₁₂ -10 t FYM + 140:40:80 kg NPK ha ⁻¹	140.65	139.75	140.20	51.17	65.69	58.43
Organic manure dose equivalent to 100 kg N ha⁻¹						
T ₁₃ -100 kg N through FYM (based on FYM analysis)	73.39	82.14	77.76	33.40	47.53	40.46
SE (m) ±	3.08	3.79	2.32	0.98	1.16	0.64
CD at 5 %	8.98	11.05	6.77	2.85	3.39	1.87

Table.2 Herbage yield of Java citronella as influenced by different treatments of nutrient management

Treatments	Total Herbage yield (t ha ⁻¹)*		
	2009-10	2010-11	Pooled mean
T ₁ – Control	5.80	5.10	5.45
Organic manure doses (t ha⁻¹)			
T ₂ - 5 t FYM ha ⁻¹	9.27	11.98	10.62
T ₃ - 10 t FYM ha ⁻¹	11.07	14.41	12.74
NPK fertilizer doses (kg ha⁻¹)			
T ₄ - 80:20:40 kg NPK ha ⁻¹	16.54	17.80	17.17
T ₅ - 100:30:60 kg NPK ha ⁻¹	17.90	18.91	18.41
T ₆ - 140:40:80 kg NPK ha ⁻¹	19.85	19.89	19.87
Combined doses (O. M. + NPK fertilizer)			
T ₇ - 5 t FYM + 80:20:40 kg NPK ha ⁻¹	18.84	20.70	19.77
T ₈ - 5 t FYM + 100:30:60 kg NPK ha ⁻¹	20.68	21.66	21.17
T ₉ - 5 t FYM + 140:40:80 kg NPK ha ⁻¹	22.86	22.63	22.75
T ₁₀ -10 t FYM + 80:20:40 kg NPK ha ⁻¹	21.70	24.23	22.97
T ₁₁ -10 t FYM + 100:30:60 kg NPK ha ⁻¹	23.74	24.86	24.30
T ₁₂ -10 t FYM + 140:40:80 kg NPK ha ⁻¹	25.82	27.06	26.44
Organic manure dose equivalent to 100 kg N ha⁻¹			
T ₁₃ -100 kg N through FYM (based on FYM analysis)	12.14	16.14	14.14
SE (m) ±	0.61	0.50	0.36
CD at 5 %	1.78	1.46	1.05

* Total herbage yield of three cuttings of each year

The pooled data revealed that among the FYM treatments, the application of FYM equivalent to 100 kg N (T₁₃) produced significantly higher herbage yield by 33.15 and 10.99 per cent than application of 5 t FYM ha⁻¹ (T₂) and 10 t FYM ha⁻¹ (T₃), respectively. The application of graded doses of NPK @ 140:40:80 kg NPK ha⁻¹ (T₆) gave 15.73, 7.93, 87.10 and 55.97 per cent higher herbage yield as compared to T₄ (80:20:40 kg NPK ha⁻¹), T₅ (100:30:60 kg NPK ha⁻¹), T₂ (5 t FYM ha⁻¹) and T₃ (10 t FYM ha⁻¹), respectively. The application of combined doses of FYM + NPK significantly increased the herbage yield and significantly highest herbage yield was noticed with the application of 10 t FYM + 140:40:80 kg NPK ha⁻¹ (T₁₂) by 86.99, 33.06 and 8.81 per cent over treatments T₁₃, T₆ and T₁₁, respectively.

From the results, it can be concluded that the conjunctive use of FYM along with chemical fertilizer (10 t FYM + 140:40:80 kg NPK ha⁻¹) was found beneficial way of nutrient management to increase the plant height, number of tillers and herbage yield of Java citronella.

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