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AK Tripathi
Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

MN Nagrauiya
Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

SP Tiwari
Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Correspondence
AK Tripathi
Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Effect of fertility levels on yield of Lemon grass (*Cymbopogon flexuosus* Nees) under irrigated farming system

AK Tripathi, MN Nagrauiya and SP Tiwari

Abstract
Lemon grass was cultivated at different fertility levels for two years for the herbage and oil yield under irrigated conditions in Balrampur, which is situated in Northern hill zone of Chhattisgarh, having 1455 mm average rainfall with average temperature of 41 ºC in summer and 3.2 ºC in winter. Five fertility levels *viz*. $N_{75}P_{30}K_{30}$, $N_{100}P_{30}K_{30}$, $N_{125}P_{30}K_{30}$, $N_{75}P_{30}K_{30}$+FYM@10 t ha^{-1} and FYM alone @ 25 t ha^{-1} were tested, where the application of NPK are 125, 100, 75 and 30 kg ha^{-1} as mentioned in the corresponding treatments. The crop was harvested thrice in a year from June to February. The effects of treatments were evaluated in terms of fresh herbage, oil yields and oil contents. The herbage yield was 976.05 q ha^{-1} which was 2% higher than second year's crop. The overall herbage yield was recorded maximum in second harvest. The suitable nutrient dose was worked out as 75 kg N + 30 kg P +30 kg K + 10 t FYM ha^{-1}. Similar trend was observed in case of oil yield *i.e.* 553.59 kg ha^{-1} on application of 75 kg N + 30 kg P +30 kg K + 10 t FYM ha^{-1} but on application of 25 t FYM ha^{-1} it was recorded 364 and 378 kg ha^{-1} during 1st and 2nd year respectively. The results were found statistically significant.

Keywords: fertility levels, *Cymbopogon flexuosus, irrigated farming system*

Introduction
Lemon grass scientifically known as *Cymbopogon flexuosus* Nees occupies important place amongst aromatic plants at national and international market, due to high level of citral (about 75-80%) in its oil in the state of Chhattisgarh, it is cultivated in more than 216 hectares, distributed in the districts of Surguja, Bastar, Rajnandgaon and Durg (Anonymous, 2002). Due to the increasing demand of lemon oil, several researchers have been working to enhance the quality and quantity of oil in different types of soil. The topography of Northern Hill Zone of Chhattisgarh is suitable to cultivate commercial perennial crops for meeting the industrial demand with better profit than traditional crops. Present study was focused to find out the suitable fertility status for cultivation of lemon grass under irrigated farming system.

Materials and Methods
The study was carried out on alfisols, texturally recognized as sandy loam in two consecutive years. Balrampur is situated at 20º 8′ north latitude and 83º 5′ east longitude at an altitude of 593 m above MSL. The soil was sandy loam with 0.3% organic carbon, 178 kg ha^{-1} available N, 16.5 kg ha^{-1} P_2O_5, 280 kg ha^{-1} K_2O and 5.9 pH. The treatments comprised of five fertility levels *viz*. $N_{75}P_{30}K_{30}$, $N_{100}P_{30}K_{30}$, $N_{125}P_{30}K_{30}$, $N_{75}P_{30}K_{30}$+FYM@10 t ha^{-1} and FYM alone @ 25 t ha^{-1} which were laid out in Randomized Block Design with three replications. Lemon grass cultivar "CKP-25" was planted through rooted slips in June. Full doses of phosphorus through Single Super Phosphate, potassium through Muriate of Potash and FYM as per treatment along with a uniform dose of chlorpyriphos dust @ 20 kg ha^{-1} were applied as basal just before planting. Nitrogen through Urea (as per treatments) was applied in three equal splits each, at planting, first harvest and second harvest in each year, Basal application of fertilizers for second year crop was done after final harvest of first year crop. Experimental crop was raised under irrigated condition and irrigations were given as per need of the crop. Herbage was harvested 3 times in each year at the intervals of 120, 150 and 90 days for monsoon crop, winter crop and summer crop respectively. Weather parameters did not show much variation during both years of study, the effects of treatments were evaluated based on fresh herbage and oil yields and oil content in herbage.

Results and Discussion
Herb yield increased significantly with increasing fertility up $N_{125}P_{30}K_{30}$ in first and second harvests during first year. In all other harvests, increase in yield over $N_{100}P_{30}K_{30}$ was not

significant. In other four harvests, $N_{75}P_{30}K_{30}$+FYM@10 t ha^{-1} produced yield at par with highest dose of $N_{125}P_{30}K_{30}$. In all the cases, application of FYM alone produced significantly poor herbage yield. Total herb yield obtained during first year was maximum (1104.26 q ha^{-1}) at $N_{125}P_{30}K_{30}$, which remained at par with $N_{100}P_{30}K_{30}$ and was significantly higher than all other fertility levels.

Table 1: Herbage yield (q/ha) of Lemon grass under different fertility levels

Treatments	First year				Second year				Total yield in 2 years (t ha^{-1})
	I harvest	II harvest	III harvest	Total	I harvest	II harvest	III harvest	Total	
$N_{75}P_{30}K_{30}$	296.11	414.89	269.92	980.92	331.88	319.73	302.38	953.99	193.49
$N_{100}P_{30}K_{30}$	330.05	448.52	286.23	1064.80	354.30	353.15	317.77	1025.22	209.00
$N_{125}P_{30}K_{30}$	345.20	464.54	294.52	1104.26	362.33	365.86	323.95	1052.14	215.64
$N_{75}P_{30}K_{30}$+10 t ha^{-1} FYM	313.07	445.27	288.1	1046.45	360.65	361.74	325.58	1047.97	209.44
FYM@25 t ha^{-1}	177.79	290.27	215.77	683.83	237.98	215.59	245.98	699.55	138.34
S.Ed.+_	7.30	5.32	5.13	19.58	5.56	4.58	5.86	19.57	5.61
C.D.(P=0.05)	14.78	10.78	10.39	39.64	11.26	9.27	11.87	39.62	11.36
Overall mean	**292.44**	**412.70**	**270.91**	**976.05**	**329.43**	**323.21**	**303.13**	**956.17**	**193.22**

*where the application of NPK are 125,100, 75 and 30 kg ha^{-1} as mentioned in corresponding treatments

In second year, total herb yield was maximum (1052.14 q ha^{-1}) at $N_{125}P_{30}K_{30}$ level and was significantly higher over the yields at $N_{75}P_{30}K_{30}$ and FYM alone. The over all herb yield obtained from two years of study was maximum of 215.64 t ha^{-1} at $N_{125}P_{30}K_{30}$ fertility which was 6.20 t ha^{-1} (2.96%), 6.64 t ha^{-1} (3.18%), 22.15 t ha^{-1} (11.45%) and 77.30 t ha^{-1} (55.88%) higher than the herbs yield at $N_{75}P_{30}K_{30}$+FYM, $N_{100}P_{30}K_{30}$, $N_{75}P_{30}K_{30}$ and FYM alone respectively. The application of FYM alone @ 25 t ha^{-1} could not compete with other fertility levels and thus produced significantly minimum herb yield in all harvests during both the years.

Table 2: Oil content (%) of Lemon grass under different fertility levels

Treatments	First year				Second year				Overall mean
	I harvest	II harvest	III harvest	Mean	I harvest	II harvest	III harvest	Mean	
$N_{75}P_{30}K_{30}$	0.522	0.478	0.555	0.518	0.490	0.508	0.570	0.523	0.520
$N_{100}P_{30}K_{30}$	0.513	0.462	0.548	0.508	0.478	0.492	0.556	0.509	0.509
$N_{125}P_{30}K_{30}$	0.495	0.440	0.535	0.490	0.457	0.475	0.552	0.495	0.492
$N_{75}P_{30}K_{30}$+10 t ha^{-1} FYM	0.523	0.485	0.555	0.521	0.495	0.515	0.578	0.529	0.525
FYM@25 t ha^{-1}	0.532	0.502	0.570	0.535	0.505	0.522	0.590	0.539	0.537
S.Ed.+_	0.012	0.008	0.008	-	0.008	0.010	0.010	-	-
C.D.(P=0.05)	0.025	0.016	0.17	-	0.016	0.019	0.019	-	-
Overall mean	**0.517**	**0.474**	**0.553**	**-**	**0.485**	**0.503**	**0.569**	**0.519**	**0.517**

*where the application of NPK are 125,100, 75 and 30 kg ha^{-1} as mentioned in corresponding treatments

Table 3: Oil yield (Kg/ha) of Lemon grass under different fertility levels

Treatments	First year				Second year				Overall mean
	I harvest	II harvest	III harvest	Mean	I harvest	II harvest	III harvest	Mean	
$N_{75}P_{30}K_{30}$	155.07	198.53	149.85	503.47	162.87	162.57	172.42	497.86	1001.33
$N_{100}P_{30}K_{30}$	169.62	207.97	156.80	534.39	169.58	174.27	178.5	521.90	1056.29
$N_{125}P_{30}K_{30}$	171.35	204.90	157.67	533.92	166.15	174.15	177.45	517.75	1051.67
$N_{75}P_{30}K_{30}$+10 t ha^{-1} FYM	164.0	216.50	159.98	540.48	178.87	186.62	188.10	553.59	1094.07
FYM@25 t ha^{-1}	94.90	146.20	122.97	364.07	120.40	112.83	145.20	378.43	742.50
S.Ed.+_	2.98	4.84	3.18	12.92	2.99	3.68	4.58	10.00	10.47
C.D.(P=0.05)	6.03	9.79	6.43	26.16	6.06	7.45	9.27	20.24	21.03
Overall mean	**150.99**	**194.82**	**149.45**	**495.27**	**159.57**	**162.09**	**172.24**	**493.91**	**989.18**

*where the application of NPK are 125,100, 75 and 30 kg ha^{-1} as mentioned in corresponding treatments

Oil yield behaved in a similar manner to herb yield. Total oil yield during first year was 540.48 kg ha^{-1} at $N_{75}P_{30}K_{30}$ + FYM fertility level and was significantly higher over the oil yields at $N_{75}P_{30}K_{30}$ and FYM alone. The application of $N_{75}P_{30}K_{30}$ + FYM produced significantly maximum total oil yield (553.59 kg ha^{-1}) during second year. In all cases, oil yield obtained was significantly minimum with application of FYM alone. The overall total oil yield obtained was 1094.07 kg ha^{-1} at $N_{75}P_{30}K_{30}$ + FYM level which was 42.40 kg ha^{-1} (4.03%), 37.78 kg ha^{-1} (3.58%), 92.74 kg ha^{-1} (9.26%) and 351.57 kg ha^{-1} (47.35%) higher than the oil yields at $N_{125}P_{30}K_{30}$, $N_{100}P_{30}K_{30}$, $N_{75}P_{30}K_{30}$ and FYM alone respectively. Oil content showed reduction with increasing levels of fertility in almost all the cases.FYM alone and $N_{75}P_{30}K_{30}$ + FYM being at par with each other had significantly higher oil content than remaining fertility levels in almost all harvests. On overall mean basis of two years of observations, FYM alone contained maximum of 0.537% herb oil content followed by 0.525, 0.520, 0.509 and 0.492% oil at fertility levels of $N_{75}P_{30}K_{30}$ + FYM, $N_{75}P_{30}K_{30}$, $N_{100}P_{30}K_{30}$, and $N_{125}P_{30}K_{30}$ respectively. These findings are in accordance with the results obtained by Ghosh and Chaterjee (1976), Rao *et al*. (1985), Samiullah *et al*. (1988), Singh (1999) and Singh *et al*. (1997).

It is an established fact that fertilization either in organic or

inorganic form is the most important factor for exploiting inherent potential of crops to the maximum possible extent. About 50% of total cultivated area in the zone is slopy with varying gradients, unbunded, locally called as dand. Rice, niger, sesame and kulthi are the crops traditionally grown in such land situations with very poor productivity. Lemon grass may become a remunerative and better alternative to these unprofitable crops.

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