THE INFLUENCE OF SLOW RELEASE AND CONVENTIONAL NITROGEN FERTILIZERS ON PLANT GROWTH AND CHEMICAL CONSTITUENTS OF *Cymbopogon citratus* Hort. GROWN IN SANDY SOIL

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ABSTRACT

In newly reclaimed sandy soil, green house experiments have been conducted in N.R.C. to evaluate the beneficial effect of coating soluble fertilizer (urea and ammonium nitrate) with insoluble materials (rock phosphate, pentonite and elemental sulpher) on growth and chemical constituents of *Cymbopogon citratus*. Results showed that the maximum values for plant height, no. of tillers, fresh and dry weights of herbage were obtained with rock phosphate coated urea, while the minimum values were recorded with uncoated nitrogen fertilizer and control.

The content of chlorophyll a, b, carotenoids, total carbohydrates, soluble sugars and phenolic compound were increased with slow release nitrogen fertilizer. The essential oil percent was the highest with rock phosphate coated urea which gave 48.28 and 61.54 % higher over uncoated urea in the first and second cut respectively. Variable effects (ascending or descending) were noticed in the content of some components of lemongrass oil as affected with slow release and conventional nitrogen fertilizers. The main compounds of lemongrass oil (neral, geranial and citronellol represented about 80 % of the essential oil. The application of sulphur and pentonite coated urea caused a depression in neral and geranial in the same time gave the greatest increase in citronellol and neryl acetate, Moreover the maximum relative concentration of myrcene (3.84 %), limonen (9.39 %) and linalool (4.46 %) were recorded from applied urea as rock phosphate coated urea compared with other treatments and control.

The macronutrients (N, P, K and S) and micronutrients (Fe and Zn) status were increased with slow release nitrogen fertilizer. It might be concluded that, the application of slow release nitrogen fertilizer had the beneficial effect for increasing plant growth and chemical constituents as compared with conventional nitrogen fertilizers, and the most effective treatment was urea coated with rock phosphate.

Keywords: Slow release nitrogen fertelizer, Medicinal and A,romatic Plant, Lemongrass, Sandy Soil

INTRODUCTION

Lemongrass (*Cymbopogon citratus*Hort.), family, Poaceae (Gramineae), a perennial herb widely cultivated in the tropics and subtropics. Propagation is by rhizomes or plant division. The quality of lemongrass oil is generally determined by the content of citral, the aldehyde responsible for lemon odor is processed to yield β-ionones which serve as starting material for the synthesis of Vitamin A (Neelam *et al*., 1993). Some other constituents of the essential oils are geranyl acetate, linayl acetate, geranial, neral, limonene, myrcine, β-Caryophyllen (Shirley, 1993). Oil from lemongrass is widely used as a fragrance in perfumes and Cosmetics, and as mask for disagreeable odors in several industrial products (Kulkarni, 1997). It is used in cases of acne, althea's foot, excessive perspiration, flatulence, insect repellent, muscleaches, oily skin, scabies, stress (Julia, 1995). As a medicinal plant, lemongrass has been considered a carminative, antimicrobial (Horne *et al*., 2001) anti-oxidant (Dorman *et al*., 2000), central nervous system depressant, has antibacterial, antifungal and antiviral activites(Chao and Young 2000), The essential oils may also have some pesticide and mutogenic activities.

Lemongrass, is one of the most important aromatic and medicinal plants, being a foliage rich crop, it responded well to nitrogen fertilization.

In addition, the plant is perennial in nature, the nitrogen fertilizer applied at the time of initial growth may not be fully utilized by the plant and much of the excess nitrogen will be lost by leaching and/or volatilization. Nitrogen fertilizers, leaching losses of nitrogen on sandy soils vary from 30 to 70 % depending on the type of applied fertilizers (Seng, 1986).

Nitrogen are known to be highly susceptible to leaching whereas ammonium form of nitrogen is resistant to leaching owing to its adsorption by the soil colloids. Fertilizer N losses form the soil could be controlled by using slow release nitrogen fertilizers. Earlier works, Zhou and Zhou (1995) revealed that, slow release fertilizers provided plant nutrients, stimulated plant growth, promoted nitrogen fixation, increased fertilizer efficiency, improved crop quality and increased yield. Moreover, N uptake and recovery of applied urea were significantly greater with coated urea materials than with prilled urea. Dou and Alva (1998) showed that various N losses were lower from the controlled release fertilizers source than from soluble fertilizers.

The present investigation was undertaken to evaluate the beneficial effect of coating soluble fertilizer (urea and ammonium nitrate) with insoluble material (rock phosphate, pentonite and elemental sulphur) on growth, yield and chemical constituents of *lemongrass* grown in newly reclaimed sandy soil.

MATERIALS AND METHODS

A greenhouse experiment was conducted in the National Research Centre, Cairo, Egypt during the two successive seasons of 1999/2000 and 2000/2001 to study the effect of applied slow release and conventional nitrogen fertilizers on production of *Cymbopogon citratus*Hort.*(lemongrass)* grown in newly reclaimed sandy soil. On 15 August, Healthy, 45 day old seedlings of lemongrass, (small shoots with roots separated from a stock plants grown in the Experimental Farm of Medicinal and Aromatic Plant Department at Giza) were transplanted into clay pots(30cm in diameter) filled with 12 kg of sandy soil collected from East Nobaria.

The soil had the following characteristics pH 8.52, E.C. 1.1 $dS.m^{-1}$ organic matter 0.32 %, $CaCO_3$ 3.2 %, total nitrogen 0.013 % available N 18.9 ppm, clay 5.25 %, silt 7.00 %, Sandy 87.75 %.

At the time of transplanting, the nitrogen fertilizers were applied at rate of (1.2 g N/pot) as the forms of applied nitrogen fertilizer were as follows:

1.	Control	without N
2.	Urea (granules)	(U) 46.5 % N
3.	Sulphur coated urea	(SCU) 30 % N
4.	Bentonite coated urea	(BCU) 30 % N
5.	Rock phosphate coated urea	(RCU) 30 % N
6.	Ammonium nitrate	(AN) 33.5 % N
7.	Sulphur coated ammonium nitrate	(SCAN 23 % N

8. Bentonite coated ammonium nitrate (BCAN) 23 % N
9. Rock phosphate coated ammonium nitrate (RCAN) 23 %. N

Nitrogen fertilizers coated with different materials were produced as El-Ashry, (1992) technique.

Basal fertilizers of phosphorus and potassium were applied to all pots at rates of 0.36g p and 0.36g k /pot. as single super-phosphate and potassium sulphate respectively. All treatments were replicated three times in a completely randomized design.

The plants were harvested two times (March and August) during the growing season. At each harvest, plant height, number of tillers, fresh and dry herbage yield were recorded.

The determination of pigments (chlorophyll a, b and total carotenoids contents) in the fresh herb were carried out according to (Wettstein, 1957). Total carbohydrate, soluble sugars percentage were determined in dry herb according to Dubois *et al*. (1956). Phenolic compound were determined according to A.O.A.C. (1970) technique. The essential oil percentage of fresh herb was determined by hydrodistilation on clevenger's apparatus according to the Egyptian Pharmacopoeia (1985). The oil constituents were determined by gas chromatography (Perkin Elmer model 8500) coluemn 2m X 4 mm filled with 10 % carbowx K 20M, nitrogen carriers gas 30 ml/min.) equipped with FID, an electronic area in tegrator, and a temperature program cycle of 90°C for 2 min., a rise of 8°C/min to 170°C, held at 170°C for 4 min., and a rise of 10°C/min. to 210°C, and held at 210 for 5 min. The qualitative determination of the different constituents of lemongrass oil was performed by comparing the relative retention times of different peaks with those of the pure authentic sample. The quantitative determination of each compound was calculated on the basis of peak area a corresponding to each compound. Total nitrogen in plant was determined according to Bremner and Mulvaney (1982). Phosphorus and potassium were determined by the method described by Cottenie *et al*. (1982). Sulphur was determined according to Dewis and Freitas (1970). Microelements content (Fe and Zn) were determined using atomic absorption. The macronutrients (N, P, K and S) and micronutrients (Fe and Zn) uptake was calculated from dry weight yields and percentage of the nutrients in samples. Data were statistically analyzed according to Sndecor and Cochran (1967).

RESULTS AND DISCUSSION

Data presented in Table (1) showed that, coating ammonium nitrate and urea with various coating materials, i.e. rock phosphate, pentonite and elemental sulphur significantly increased plant height, number of tillers, fresh and dry weight of herbage as compared with both uncoated fertilizers and control, and the increase were more pronounced with urea than ammonium nitrate. This response may be attributed to leaching losses of either N-urea or N-NH_4 NO_3 in sandy soils vary from 30 % to 70 % depending on the type of applied fertilizers (Seng, 1986), whereas coating ammonium nitrate and urea fertilizer with various coating materials, reducing its solubility, releasing into the soil and consequently a higher availability of N was maintained to the plant. In this respect, Muni-Ram *et al*. (1989) on Japanese mint, Singh and Singh (1992)on *Cymbopogon winterianus* Jowett. Moreover Ayyer (1992), who found that fertilizer N losses from the soil could be controlled by coating soluble fertilizer with insoluble materials,also Singh *et al*. (1997b) on *Coriandrum sativum* and Singh (1999)on *Pelargonium graveolens.* Slow release N materials are used to reduce N leaching losses from sandy soils and extend N availability over a growing season (Guertal, 2000). Moreover, nitrogen applied as rock phosphate coated urea was the most effective treatment for increasing plant height, number of tillers, fresh and dry weight of herbage followed by pentonite and sulphur coated urea. Similar results were obtained in the second season. These results agreed with Saroka *et al*.(1994)on rye and barley , Mishra *et al*. (1995)on betel leaves.

The results in Table (2) revealed that, the chlorophyll a, b and carotenoids content in leaves of *Cymbopogon citratus* significantly increased with all nitrogen sources compared with the control, and the increased was more pronounced with slow release nitrogen fertilizer than with conventional nitrogen (urea and ammonium nitrate). Moreover, the greatest increase occurred when urea applied as rock phosphate coated urea. The results agreed with that reported by Naglaa and Hassan (1995) on *Daracaena marginata* and Rambola *et al*. (1997)on peach orchard. Test and Lenzi (1998) found that, a correlation was noticed between nitrate content and the intensity of the green colour of *Lactuca sativa* leaves measured by a chlorophyll meter, and Perin *et al*., (1999) found that the chlorophyll leaf level of *Citrus limonia* increased with controlled release fertilizer.

Total carbohydrate, soluble sugars and phenolic compound were significantly affected with all nitrogen fertilizers as compared with the control. In addition urea and ammonium nitrate coated with different material significantly increased total carbohydrate, soluble sugar and phenolic compound content compared with uncoated fertilizers (urea and ammonium nitrate), and the increase was greater in urea than ammonium nitrate. In this respect, Ram *et al*., (1999) found that, fruit quality and reducing sugars of guava were improved with the application of slow release fertilizers, and Hooda and Srivastava (1998) revealed that slow release fertilizers affected biochemical constituents (cellulose, hemicelulose, lignin, Silica, total proteins and total phenols) of the host plants.

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The data also, showed that applying different nitrogenous fertilizers caused a primitive effect on increasing the essential oil percentage of lemongrass plants compared with the control and the increases were much greater with urea and ammonium nitrate coated with different material than uncoated fertilizer .Moreover, the maximum increase was obtained with rock phosphate coated urea, which gave 48.28 and 61.54 % higher over that with uncoated urea in the first and second cut, respectively. This might be attributed to decreasing N- leaching losses from coated fertilizers and consequently increasing N- availability in the soil which was maintained to the plant. The identified components of lemongrass oil and their percentages are given in Table (3). The detected constituents of the essential oil were myrcene, limonene, P-cymene, β-caryophlleme, citronellol, linalool, neral, geranial, citronellal, geranyl formate, neryl acetate, and caryophllen oxide. The major compounds were found to be geranial and neral, which ranged in the present treatments from 32.48 to 51.58 % and from 10.67 o 28.83 %, respectively, indicating that geranial was more predominate. The results showed that geranial, neral and citronellal represented about 80 % of the oil at all treatments. Moreover, the relative concentration of limonene ranged from 5.82 to 9.39 %. Variable effects (ascending or descending) were noticed in the content of some compounts of lemongrass oil as affected with slow release and conventional nitrogen fertilizers. The maximum relative concentration of myrcene (4.84 %), limonene (9.39 %) and linalool (4.46 %) were recorded from urea applied as rock phosphate coated urea. Moreover, the main compounds of lemongrass oil (neral, geranial and citronellol which represented about 80 % of the oil were not affected with most of nitrogen fertilization treatments. These results agreed with that reported by Singh *et al*. (1997a) on *Cymbopogon flexusous,* also Singh (1999) on *Pelargonium graveolens*, revealed that the quality of essential oil were not influenced either by soil moisture regime, rates or carriers of N. On the other hand the application of sulphur and pentonite coated urea caused a depressions in
neral and geranial, in the same time gave the greatest increase in citronellol and neryl acetate.

Tables (4 and 5) showed that the status of nutrient in plant improved by addition of studied fertilizers compared with the control. Results also showed that the increase were more pronounced with urea than ammonium nitrate, these results indicated that AN fertilizer release its nitrogen fractions slightly more than urea. Possibly due to relatively more effect for AN dissociation compared to urea hydrolysis could be attributed to delaying urea hydrolysis and consequently the production of its ammonium ions in the experimental soil. Values representing in the same tables indicated the nutrients status were improved by coated fertilizers addition as compared to uncoated fertilizers. This effect possibly attributed to reducing N- losses and increasing N- use efficiency of the coating fertilizers during the two successive cuttings. Moreover, the application of rock phosphate coated urea or ammonium nitrate gave the greatest increase for nutrient status followed by elemental sulphur and pentonite coated fertilizers.

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Generally out-performed noncoated fertilizers in reducing N leaching losses, stimulating plant growth and increasing tissue N concentration (Mikkeleen *et al*., 1994). Sekimoto *et al*., (1997) found that the concentration of N, P and K from control release fertilizer was sufficient for growth of lettuce plant. Dou and Alva (1998) found that total N uptake by citrus seedling was greater from controlled release fertilizers than from soluble fertilizers. Nyborg *et al*. (1999) revealed that thick-coated urea had greater N uptake in grain straw compared to noncoated urea. Moreover, Awad *et al.* (1990) showed that slow P released from the coated fertilizers should be considered helpful for less in solubilization for phosphates and thus more uptake by plants. Also the highest leaf P and Zn concentration for *Daracaena morginata* were obtained with slow release sticks (Naglaa and Hassan, 1995).

Data presented in Table (6) showed that the amount of available N fractions ($NH_4$and NO_3) remained in soil after plant harvest were increased as a result of using coated fertilizers with various coated materials compared to uncoated urea and ammonium nitrate. It was noticed that coated urea with sulphur, pentonite and rock phosphate resulted in a highest value of residual nitrogen due to its low dissolution rate. However RCU gave pronounced value of residual nitrogen forms. Generally, controlled release fertilizers tend to release their nitrogen in regulation, as the plants need.

Table (6): Residual ammonium and nitrate (ppm) in soil after plant harvest.

Treatments	NH_4	NO_3	(NH_4+NO_3)
Control	6.5	3.48	9.98
U	10.6	8.2	18.8
SCU	20.2	9.7	29.9
BCU	22.4	11.2	33.6
RCU	26.9	15.7	42.6
AN	9.7	6.7	16.4
SCAN	11.2	7.4	18.6
BCAN	13.4	7.9	21.3
RCAN	20.2	8.8	29.0

It might be concluded that the application of slow release nitrogen fertilizer had the beneficial effect for increasing plant growth and chemical constituents as compared with conventional nitrogen fertilizers because of reducing N-losses and consequently increasing N-efficiency.So, slow release fertilizer seemed to be applicable in newly reclaimed sandy soil.

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تأثير استخدام الأسمدة النتروجينية بطيئة التحلل والأسمدة النتروجينية التقليدية على النمو والمكونات الكيمائية لنبات حشيشة الليمون النامي في الأراضي الرملية.

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**** قسم الأراضي واستغلال المياه – المركز القومى للبحوث – الدقى – القاهرة**

من أجل التغلب على مشكلة نقص إنتاج الأراضي المصرية خاصة المستصلحة حديثا والذي يرجع جزئيا للفقد الكبير في الأسمدة النتروجينية، تم إجراء تجربة أصص ممتلئة بالتربة الرملية من منطقة النوبارية ودراسة تأثير تغليف الأسمدة العادية (اليوريا ونترات الامونيوم) لانتاج أسمدة بطيئة التحلل وذلك باستخدام مواد طبيعية وهى صخر الفوسفات والبنتونت وعنصر الكبريت وتأثير ذلك على النمو والمكونات الكيميائية لنبات حشيشة الليمون .

وقد أوضحت النتائج أن سماد اليوريا المغلف بصخر الفوسفات له تأثير كبير على زيادة طول النبات وعدد الخلفات والوزن الطازج والجاف لنبات حشيشة الليمون .

زاد محتوى النبات من كلوروفيل أ ، ب والكاروتينيدات والسكريات الكلية والذائبة والفينولات باستخدام الأسمدة بطيئة التحلل وكذلك زادت النسبة المئوية للزيت خاصة باستخدام اليوريا المغلفة بصخر الفوسفات في الحشة الأولى تصل إلى ٤٨,٢٨ % و في الحشة الثانية إلى ٦١,٥٤ % عن أسمدة اليوريا الغير مغلفة .

أظهرت نتائج تحليل الزيت الطيار أن المركبات الرئيسية هى : بالكبريت والبنتونيت إلى نقص في مكون neral , geranial غي(neral, geranial and citronellol) والتي تكون حوالي ٨٠ % منه. أدى استخدام اليوريا المغلفة ر أنها أدت إلى الزيادة في كل من مركب neryl acete and citronellol .

كما أدى استخدام اليوريا المغلفة بصخر الفوسفات إلى زيادة مركب myrcene (٤,٨٤ %) و مركب limonen (٩,٣٩ %) ومركب linalool (٤,٤٦ %) .

زاد محتوى النبات من العناصر الكبرى (النتروجين والفوسفور والبوتاسوم والكبريت) وكذلك العناصر الصغرى (الحديد والزنك) وذلك باستخدام الأسمدة بطيئة التحلل مقارنة بالأسمدة الغير مغلفة و معاملة المقارنة .

وعموما كان للأسمدة بطيئة التحلل تأثير كبير في زيادة نمو النبات والمكونات الكيمائية وذلك مقارنة بالأسمدة النتروجينية العادية وكانت افضل المعاملات تأثيرا هى اليوريا المغلفة بصخر الفوسفات .

Table (1) : Effect of slow release and conventional nitrogen fertilizers on plant

Treatments	First season								Second season							
	Plant height (cm)		No. of tillers		Fresh wt. g/plant		Dry wt. g/plant		Plant height (cm)		No. of tillers		Fresh wt. g/plant		Dry wt. g/plant	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Control	68.33	85.00	2.33	3.33	40.19	50.61	8.31	11.44	73.33	80.00	2.67	3.00	43.69	53.57	9.67	12.50
U	79.33	104.00	3.67	5.33	46.77	66.57	10.23	16.11	90.00	105.00	4.00	5.33	51.89	64.50	12.66	15.83
SCU	89.00	111.33	4.67	6.33	50.43	72.23	12.46	17.08	101.67	110.00	5.00	6.67	56.18	68.77	14.30	16.96
BCU	95.00	117.00	5.33	7.33	58.04	80.54	15.23	18.42	108.33	118.33	5.67	8.00	59.67	78.57	15.46	18.93
RCU	101.67	121.67	6.67	8.33	61.97	86.97	16.41	19.90	121.67	130.00	7.00	9.33	64.27	92.85	16.60	20.33
AN	72.33	93.67	3.67	4.33	43.07	56.07	8.80	14.13	81.67	97.00	3.67	4.00	46.37	57.60	10.83	14.60
SCAN	80.67	99.00	4.67	5.30	45.99	61.98	10.33	15.06	88.00	100.00	4.00	5.67	48.33	60.13	11.61	15.43
BCAN	85.00	105.00	4.67	6.33	49.67	69.98	12.44	16.13	93.00	107.00	5.00	6.67	51.33	66.57	12.90	16.53
RCAN	90.33	112.67	5.67	7.33	54.57	75.17	14.41	17.22	100.00	113.00	6.00	8.00	55.30	72.03	14.37	17.51
L.S.D. at 0.05 %	4.37	3.52	1.01	0.79	2.05	5.35	0.30	0.87	4.87	2.50	0.58	1.25	1.93	3.97	0.67	0.69

U =Uer **AN =Ammonium**
nitrate
SCU=Sulphur coated uera **SCAN=Sulphur**
coated Ammonium nitrate
BCU=Bentonite coated uera **BCAN=Bentonite**
coated Ammonium nitrate
RCU=Rock Phosphate coated uera **RCAN=Rock**
Phosphate coated Ammonium nitrate

Table (2) : Effect of slow release and conventional nitrogen fertilizers on chemical constituents of *Cymbopogon citratus* grown in sandy soil during 1999/2000 season.

Treatments	Chlorophyll-a mg/g fresh weight		Chlorophyll-b mg/g fresh weight		Carotenoids mg/g fresh weight		Total carbohydrate %		Soluble sugar %		Essential Oil %		Phenolic compound mg/g dry weight	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Control	0.76	0.89	0.38	0.44	0.37	0.40	13.89	14.22	2.73	2.93	0.22	0.29	3.18	1.17
U	1.11	1.15	0.46	0.76	0.42	0.46	15.44	16.71	3.47	3.80	0.29	0.39	4.14	1.64
SCU	1.70	1.83	0.53	1.13	0.43	0.50	18.00	18.77	4.00	4.37	0.38	0.52	4.55	1.72
BCU	1.67	1.69	0.50	0.92	0.40	0.49	19.78	21.00	5.20	5.67	0.32	0.46	5.00	1.82
RCU	1.72	1.94	0.59	1.28	0.48	0.54	21.22	22.33	5.67	6.00	0.43	0.63	5.86	1.93
AN	0.89	1.09	0.41	0.46	0.38	0.43	14.67	15.89	3.00	3.37	0.26	0.32	3.55	1.40
SCAN	1.17	1.39	0.48	0.62	0.42	0.46	16.45	17.00	3.40	3.83	0.31	0.38	3.90	1.49
BCAN	1.10	1.18	0.44	0.49	0.40	0.44	17.22	17.81	3.90	4.30	0.27	0.35	4.10	1.57
RCAN	1.28	1.43	0.48	0.71	0.45	0.48	18.96	19.55	4.40	5.27	0.35	0.43	4.60	1.66
L.S.D. at 0.05 %	0.05	0.03	0.03	0.06	0.04	0.02	0.65	0.37	0.37	0.43	0.03	0.03	0.37	0.07

U =Uera **AN =Ammonium nitrate**
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Table (3) : Effect of slow release and conventional nitrogen fertilizers on Essential oil constituents (%) of *Cymbopogon citratus* grown on sandy soil.

Compound of essential oil	Control	U	SCU	BCU	RCU	AN	SCAN	BCAN	RCAN
Myrcene	-	2.69	1.34	1.65	3.84	1.06	2.46	1.92	1.76
Limonene	7.70	7.08	8.22	5.82	9.39	8.26	6.74	7.14	7.16
P-cymene	0.26	0.31	0.77	1.01	0.46	0.45	0.41	0.37	0.38
β-Caryophyllene	0.42	0.43	0.45	0.52	0.42	0.40	0.57	0.49	0.52
Citronellal	0.55	0.57	0.82	0.21	0.48	0.45	0.52	0.57	0.67
Linalool	1.92	1.93	1.15	1.59	4.46	3.19	2.72	2.80	3.49
Neral	28.83	28.02	20.65	10.67	27.24	27.88	28.21	26.87	27.24
Geranial	50.76	49.77	45.96	32.48	47.22	49.51	51.58	48.61	48.23
Citronellol	3.43	3.32	14.73	23.97	3.12	3.41	3.22	3.47	3.59
Geranyl formate	1.24	1.21	0.49	6.37	0.77	1.34	0.94	1.24	1.57
Neryl acetate	1.70	0.85	4.54	14.03	1.53	0.91	1.23	1.63	1.02
Caryophyllene oxide	0.51	0.56	-	-	0.33	0.72	0.23	1.36	0.78
T-identification	97.32	96.74	99.12	98.32	99.26	97.58	98.83	96.47	96.41

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Table (4) : Effect of slow release and conventional nitrogen fertilizers on nutrients content of *Cymbopogon citratus* grown in sandy soil during 1999/2000 season.

Treatments	N %		P %		K %		S %		Fe ppm		Zn pp
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut
Control	1.08	1.31	0.12	0.14	1.76	2.25	0.13	0.15	334	383	100
U	1.22	1.65	0.14	0.17	2.40	2.62	0.20	0.23	482	589	145
SCU	1.45	1.76	0.16	0.18	2.52	2.98	0.26	0.33	660	750	173
BCU	1.51	1.86	0.17	0.21	2.67	3.09	0.26	0.28	538	620	160
RCU	1.62	1.97	0.20	0.25	2.81	3.33	0.33	0.44	754	815	250
AN	1.16	1.41	0.13	0.15	2.11	2.41	0.16	0.18	390	496	132
SCAN	1.33	1.48	0.14	0.16	2.30	2.52	0.19	0.27	500	624	160
BCAN	1.39	1.54	0.14	0.18	2.38	2.70	0.20	0.23	415	536	144
RCAN	1.42	1.60	0.15	0.19	2.61	2.90	0.24	0.30	555	700	200
L.S.D. at 0.05 %	0.05	0.05	0.01	0.01	0.08	0.18	0.02	0.03	35.87	42.80	3.16

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Table (5) : Effect of slow release and conventional nitrogen fertilizers on the uptake of nutrients (mg/plant) in *Cymbopogon citratus* grown in sandy soil during 1999/2000 season.

Treatments	N		P		K		S		Fe		Zn
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut
Control	89.48	150.22	10.25	16.14	146.50	257.47	11.08	17.16	2.78	4.38	0.83
U	124.51	265.82	13.98	27.28	245.20	422.09	20.46	36.52	4.93	9.49	1.48
SCU	181.06	301.12	19.53	30.58	316.91	509.17	31.98	55.80	8.22	12.81	2.16
BCU	229.52	342.59	25.89	39.29	406.21	568.49	36.05	52.19	8.19	11.41	2.44
RCU	266.40	391.36	32.82	49.76	461.12	662.36	53.60	88.18	12.37	16.22	4.10
AN	102.38	198.67	11.16	21.72	185.68	340.95	14.08	25.87	3.43	7.01	1.16
SCAN	137.05	223.45	14.12	24.11	237.93	379.03	19.63	40.13	5.16	9.37	1.65
BCAN	172.95	248.38	17.83	29.03	296.54	435.42	25.29	37.64	5.16	8.64	1.79
RCAN	205.00	275.49	21.62	32.53	376.15	499.28	34.60	52.21	8.00	12.05	2.88
L.S.D. at 0.05 %	6.14	15.33	1.62	2.64	11.34	35.77	3.47	5.20	0.63	0.73	0.08

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