

## Effect of nitrogen and weed control on growth and yield of Java citronella (*Cymbopogon winterianus* Jowitt)

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### Abstract

Field experiments conducted at Lucknow, India on Java citronella (*Cymbopogon winterianus*) to study the effect of manual weeding (weed-free condition) and diuron spray (1.5 kg ai/ha) over weedy check (no weeding) alone and also in association with different levels of nitrogen on growth and yield revealed that fresh herbage yield in weed-free and diuron treated plots were 30 and 15 % more over unweeded plots, respectively. Growth and yield parameters in weed-free and weedy plots significantly increased with increase in nitrogen up to 200 kg N/ha and up to 150 kg N/ha in diuron treated plots. The response equation showed that optimum nitrogen doses in first harvest year were 222.22, 168.18 and 126.32 in weed-free, weedy and Diuron treated plots, respectively; in second harvest year the respective values were 176.67, 158.33 and 106.45. The net return at optimum level of nitrogen was maximum (Rs. 20,065) in weed-free plots followed by diuron (Rs. 18,120) treated plots in first harvest year, whereas in second harvest year, the respective values were Rs. 26,279 and Rs. 25,088. Weed-free plots produced maximum growth and herbage yield followed by diuron treated plots.

**Key words:** *Cymbopogon winterianus*, Java citronella, nitrogen, weed control, yield.

### Introduction

Java citronella (*Cymbopogon winterianus* Jowitt) is a foliage rich grass and steam distillation of its leaves yield an essential oil which is a natural source of citronellal, citronellol and geraniol. The oil is widely used for perfuming soaps and other household detergents. On account of its long

duration, higher water and fertilizer requirements and frequent herbage removal, supply of nitrogen in large quantities may produce higher yields and also encourage weed growth. Earlier studies on weed management in Java citronella indicated that 45-60 days after planting was the critical period for weed competition and diuron and simazine were helpful in suppress-

ing them (Yadav *et al.* 1981). The present study was undertaken to investigate the effect of nitrogen and weed control measures on growth and yield of Java citronella.

## Materials and methods

The field experiment was conducted during 1984-86 at the Research Farm of Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, India. The soil of the experimental field was sandy loam in texture with pH 7.8, organic carbon 0.21%, available N, P and K 95.0, 3.4 and 85.0 kg/ha, respectively. The treatments included manual weeding (weed-free; 8 weedings per year); diuron spray (1.5 kg at 6 month intervals; first spray of diuron was done just after planting as pre-emergence, while the subsequent application followed manual weedings); control (weedy; no weeding) and six levels of N (0, 50, 100, 150, 200 and 250 kg/ha) in combi-

nations. Weed control measures were assigned to main plots and N levels to sub-plots in a split plot design with three replications.

Healthy slips of Java citronella were planted at 45 cm x 45 cm spacing during July 1984. Phosphorus @ 22 kg/ha and potassium @ 41.5 kg/ha were applied through single super phosphate and muriate of potash, respectively. Nitrogen was applied through urea in four equal splits, each at planting and after first, second and third harvests during each year. Four harvests of herbage during each year were undertaken at equal intervals of 90 days on 30th September, 30th December, 30th March and 30th June. Plant height, number of tillers per plant and fresh herbage yield were recorded at each harvest.

For calculating the net return (or profit) per rupee investment on nitrogen, the price of Rs. 250/kg of citronella oil, Rs. 8 of nitrogen, Rs. 750/ha for hand weed-

**Table 1.** Influence of weed control and N levels on plant height\* in Java citronella

Treatment	First harvest year Timing of harvest				Second harvest year Timing of harvest			
	I	II	III	IV	I	II	III	IV
Weed control								
Weed-free	63.6	63.6	72.3	94.6	98.7	66.1	80.6	91.2
Weedy	54.6	57.4	69.9	89.1	86.0	61.6	79.5	76.0
Diuron	58.9	61.1	71.2	91.8	93.3	63.0	82.3	82.1
CD at 5%	0.63	0.63	0.69	1.05	1.05	0.99	0.76	0.90
N level (kg/ha)								
0	50.6	55.7	65.4	76.9	85.0	55.9	77.7	76.1
50	56.8	57.3	69.7	84.9	89.4	60.6	79.0	79.4
100	59.7	60.4	70.3	91.3	92.7	62.6	80.3	85.1
150	62.0	62.1	72.6	95.9	95.7	65.3	81.6	86.4
200	62.9	64.8	74.6	99.9	96.9	67.9	83.0	86.7
250	62.3	63.7	76.0	102.1	96.4	69.1	83.2	86.9
CD at 5%	1.26	0.82	0.92	0.88	0.88	0.65	0.56	1.57

I= Jul - Sept; II= Oct - Dec; III= Jan - Mar; IV= Apr - Jun

\*Values of plant height are in cm

**Table 2.** Influence of weed control and N levels on plant height\* in Java citronella during 4th harvest

N level (kg/ha)	First harvest year			Second harvest year		
	Weed -free	Weedy	Diuron	Weed -free	Weedy	Diuron
0	80.7	70.7	79.3	83.3	70.0	75.0
50	86.3	83.7	85.0	86.7	73.3	78.3
100	86.3	90.0	91.0	90.0	75.7	82.7
150	99.7	93.3	96.0	93.3	79.3	86.7
200	102.8	96.5	96.5	96.7	78.3	85.0
250	103.0	96.7	97.5	97.3	78.3	85.0
For "N" at fixed level of "W"						
CD at 5%	1.21			1.97		
For "W" at fixed or different level of "N"						
CD at 5%	1.26			1.86		

\*Values of plant height are in cm

ing and Rs. 300/ha for weed control through herbicide (diuron) were considered.

### Results and discussion

The differences in plant height and number of tillers per plant (Tables 1 & 3) due to N levels and weed control

(manual and through use of diuron) were significant during the first and second harvest years. Plant height and number of tillers during all the harvests were higher in weed-free plots followed by plots in which diuron was sprayed. Nitrogen application increased plant height and number of tillers signifi-

**Table 3.** Influence of weed control and N levels on production of tillers in Java citronella

Treatment	First harvest year Timing of harvest				Second harvest year Timing of harvest			
	I	II	III	IV	I	II	III	IV
Weed control								
Weed-free	26.1	28.3	29.1	40.3	46.1	29.6	30.6	32.2
Weedy	17.8	19.3	22.7	28.9	31.2	20.3	20.8	23.6
Diuron	22.4	24.5	25.6	33.6	39.3	25.8	26.0	28.7
CD at 5%	0.38	1.39	0.80	2.06	2.02	1.81	1.41	2.25
N level (kg/ha)								
0	14.8	16.7	19.4	26.1	30.7	17.2	18.9	19.4
50	19.7	22.2	24.3	32.2	36.8	23.3	24.4	25.8
100	22.4	24.4	26.3	34.8	39.3	25.7	26.6	28.4
150	24.7	26.4	27.8	37.2	42.2	27.7	28.7	31.1
200	26.1	27.8	29.0	38.5	42.8	29.3	29.9	32.7
250	25.0	26.7	28.0	36.9	41.6	28.2	28.3	31.6
CD at 5%	1.58	2.11	1.89	1.78	1.85	1.28	1.66	1.51

I= Jul - Sept; II= Oct - Dec; III= Jan - Mar; IV= Apr - Jun

**Table 4.** Influence of weed control and N levels on production of tillers in Java citronella during 4th harvest

N level (kg/ha)	First harvest year			Second harvest year		
	Weed-free	Weedy	Diuron	Weed-free	Weedy	Diuron
0	31.7	21.7	25.0	21.7	16.7	20.0
50	36.7	26.7	33.3	30.0	20.4	26.7
100	39.3	30.0	35.0	32.0	23.3	30.0
150	42.7	31.7	37.3	34.7	26.0	32.7
200	47.3	32.7	35.3	38.3	28.3	31.3
250	44.0	31.0	35.7	36.7	26.7	31.3
For "N" at fixed level of "W"						
CD at 5%	2.36			2.08		
For "W" at fixed or different level of "N"						
CD at 5%	2.45			2.33		

Values indicate no. of tillers/plant

cantly. The increase in plant height and number of tillers at lower doses of N was more than at higher doses and virtually there were no difference in plant height and number of tillers in the crop raised with 200 and 250 kg N/ha. Plant height and tiller production due to higher level of N has also been reported by a number of workers in Java citronella (Chandra

*et al.* 1970; Ghosh & Chatterjee 1978; Rao *et al.* 1983; 1985). Plant height and number of tillers per plant were higher during the second harvest year than in the first. The growth in terms of plant height and number of tillers per plant was higher during April-June (fourth harvest) and lower during October-December (second harvest). This might

**Table 5.** Influence of weed control and N levels on yield of fresh herbage in Java citronella

Treatment	First harvest year Timing of harvest					Second harvest year Timing of harvest				
	I	II	III	IV	Total	I	II	III	IV	Total
<b>Weed control</b>										
Weed-free	30.8	43.0	60.3	75.4	209.5	93.8	47.3	65.8	66.3	273.2
Weedy	23.8	33.5	45.7	59.9	162.9	75.2	31.2	49.8	53.7	209.9
Diuron	28.0	39.3	55.6	66.3	189.2	87.7	37.8	55.4	59.3	240.2
CD at 5%	2.06	2.63	5.88	7.02	12.51	7.28	2.28	4.8	4.1	11.78
<b>N level</b>										
(kg/ha)										
0	22.3	30.2	42.0	44.8	139.3	64.9	29.4	38.4	42.0	174.7
50	25.2	34.5	47.3	55.2	162.2	78.2	35.6	48.0	54.8	218.0
100	27.8	38.0	50.8	65.2	181.8	85.9	38.4	58.1	62.3	244.7
150	30.6	42.0	59.9	77.7	210.2	94.9	42.0	65.2	66.2	268.3
200	30.5	43.9	62.3	81.7	218.4	95.2	44.8	67.6	67.7	274.3
250	28.7	43.1	60.7	78.6	211.1	94.1	42.4	63.6	66.7	266.8
CD at 5%	1.87	3.16	4.02	6.13	7.78	5.91	2.59	4.99	4.79	10.73

I= Jul - Sept; II= Oct - Dec; III= Jan - Mar; IV= Apr - Jun

Values indicate fresh herbage yield in q/ha

**Table 6.** Influence of weed control and N levels on yield of fresh herbage in Java citronella during 4th harvest

N level (kg/ha)	First harvest year			Second harvest year		
	Weed- free	Weedy	Diuron	Weed- free	Weedy	Diuron
0	155.7	115.1	146.9	202.9	142.5	178.7
50	175.4	143.6	167.8	246.7	185.9	221.5
100	196.3	161.2	188.1	268.7	211.6	252.7
150	227.5	175.7	227.5	319.1	227.0	253.8
200	258.8	193.5	202.9	311.4	252.7	287.8
250	243.4	188.6	201.2	-	239.6	259.5
For "N" at fixed level of "W"						
CD at 5%	10.64			14.99		
For "W" at fixed or different level of "N"						
CD at 5%	17.48			21.06		

Values of fresh herbage are in q/ha

be due to the low temperatures prevailing during winter months. High temperature and bright sunshine, under irrigated conditions favoured the growth of the plants as indicated during the fourth harvest.

The interaction between N levels and weed control measures (Tables 2 & 4) revealed that during fourth harvest, increase in plant height and number of tillers under weed-free conditions was up to 200 kg N/ha, while in diuron treated plots it was only up to 150 kg N/ha.

The yield differences in fresh herbage of Java citronella (Table 5), between weed control measures and levels of N were significant during both the harvest years. Weed-free treatment yielded higher (209.6 q/ha) than plots treated with diuron (189.29 q/ha) during the first harvest year. During the second harvest year, it was 273.2 q/ha in weed-free plots and 240.2 q/ha in plots treated with diuron. The differences in fresh herbage yield can be attributed to the favourable influence of N on plant height and tiller production, which favours dry matter accumulation (Rao

*et al.* 1983; 1985; Yadav *et al.* 1984; Singh *et al.* 1996).

The interaction between weed control measures and levels of N (Table 6) were significant during all the harvests. Fresh herbage yield increased significantly up to 200 kg N/ha in weed-free (manual weeding) plots, while only up to 150 kg N/ha in diuron treated plots during both the years.

From the response curves, the optimum nitrogen dose (kg/ha<sup>-1</sup>) and oil yield (kg/ha<sup>-1</sup>) were determined as, weed-free: 222.22 and 304.57; weedy: 168.18 and 233.76 and diuron: 126.32 and 265.98. The corresponding values for second year were 176.67 and 375.77; 158.33 and 293.42; 106.45 and 329.40, respectively.

The response equations were:

$$\begin{aligned}
 \text{First year: } & \text{Weed-free} = 249.01 + 0.45x - 0.0009x^2 \\
 & \text{Weedy} = 194.24 + 0.42x - 0.0011x^2 \\
 & \text{Diuron} = 229.35 + 0.53x - 0.0019x^2 \\
 \text{Second year: } & \text{Weed-free} = 320.12 + 0.58x - 0.0015x^2 \\
 & \text{Weedy} = 240.38 + 0.62x - 0.0018x^2 \\
 & \text{Diuron} = 289.45 + 0.71x - 0.0031x^2
 \end{aligned}$$

The response per kg N under weed-free, weedy and diuron treated plots were

Table 7. Net profit at optimum levels of N under different weed control practices in Java citronella

Weed control treatments	Oil yield at optimum level of N (kg/ha)	Oil yield at 0 level of N (kg/ha)	Increase in yield over control (kg/ha)	Response per kg N applied (kg oil)	Value of increase in yield (Rs/ha)	Cost of fertilizer (Rs/ha)	Net return (Rs/ha)	Net return per rupee investment on fertilizer (Rs.)
<i>First year</i>								
Weed-free	304.6	209.2	95.4	0.43	23,842.5	1777.8	20,064.7	11.29
Weedy	233.8	155.9	77.9	0.46	19,465.0	1345.4	18,119.6	13.46
Diuron	266.0	198.7	67.3	0.53	16,820.0	1010.6	15,809.4	15.54
<i>Second year</i>								
Weed-free	375.8	265.0	110.8	0.63	27,692.5	1413.4	26,279.1	18.59
Weedy	293.4	188.0	105.4	0.67	26,355.0	1266.6	25,088.4	19.81
Diuron	329.4	234.1	95.3	0.89	23,825.0	851.6	22,973.4	26.98

0.43, 0.46 and 0.53 kg oil in the first harvest year and the corresponding figures in the second harvest year were 0.63, 0.67 and 0.89 kg/ha, respectively (Table 7). The net returns were Rs. 20,065, Rs. 18,120 and Rs. 15,809 in the first harvest year and Rs. 26,279, Rs. 25,088 and Rs. 22,973 in the second harvest year, respectively. The net returns per rupee investment were Rs. 11.29, Rs. 13.46 and Rs. 15.64 in the first harvest year and the corresponding figures in the second harvest year were Rs. 18.59, Rs. 19.81 and Rs. 26.98, respectively. Thus, under weedy situation, the efficiency in utilization of added nitrogen is drastically reduced. Further, application of diuron for weed control always shaded an edge over the benefits accrued under weed-free checks.

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