https://doi.org/10.29321/MAJ.10.A02356

Madras Agric. J. 72 (3) 133–140 - March, 1985

INFLUENCE OF THE TIME AND QUANTITY OF NITROGEN APPLICATION ON THE NITROGEN UPTAKE PATTERN IN SORGHUM (CSH.5)[1]

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Field experiments were conducted in summer and *Kharif*, 1974 under irrigation at Tamil Nadu Agricultural University, Coimbatore, to study the influence of the time and quantity of N application on the N uptake pattern in sorghum (CSH.5). Plant samples were collected from experimental plots at 10 days interval and analysed for N content. Total N uptake and uptake pattern were worked out. Application of N in 4 equal splits viz. basal, on 26th, 52nd and 80th day after sowing, gave the maximum N uptake. Rate of N uptake gradually increased up to about 40 days of sowing, reaching peak in the 40-50 day period. This coincided with the grand growth period. There was a marked fall in the uptake during the flowering stage. Rate of uptake increased again reaching the second peak in 60-70 day period. A net loss of N from plant was noticed in the period just preceding harvest.

The concept of sorghum husbandry has been revolutionised with the introduction of early maturing hybrids and varieties. The hybrids have high yield potential and to exploit this potential, sound nitrogen (N) management is essential. This envisages supply of N at the stage when the crop needs it most. Raheja and Krantz (1958) observed that N uptake curve was steeper during the 4th through 7th week of planting Sorghum (CSH. 1). The daily N uptake during this period was about 4 lb/acre. Roy and Wright (1969) reported increased uptake of N due to N application. Joshi and Morey (1970) stated that N uptake increased upto 105 day of planting and then declined. The study of N uptake pattern would throw more on the stages in which the crop takes up most of its N requirements. Based on this observation, N management for the crop could be recommended. With this objective, the study was undertaken.

MATERIALS AND METHODS

Field experiments were conducted during summer (February - May) and ***Kharif*** (July - November) seasons in 1974 with hybrid sorghum (CSH 5) in the Tamil Nadu Agricultural University Farm, Coimbatore. The treatment schedule is given in table 1. The summer experiment was conducted in a black clay loam soil high in available N, P_2O_5 and K_2O with a PH of 8.2. The ***Kharif*** experiment was conducted in

1. Forms part of M. Sc. (Agri.) Thesis of the senior author submitted to the Tamil Nadu Agricultural University, Coimbatore.

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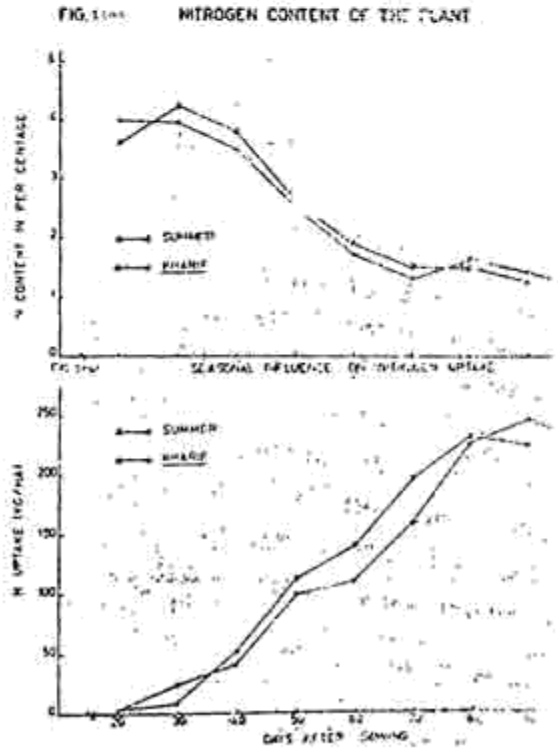
red sandy clay loam, medium in available N and P_2O_5 and high in K_2O with PH of 7.4. Fertilisers were placed approximately 5 cm away from the seed line at a depth of 5 cm. In the case of foliar application of N, concentration of urea varying from 1.32 to 5.28 per cent was applied depending on the quantity of N to be supplied, with 0.1 per cent teepol as adhesive. Two plants were removed from rows of plants specially left for sampling in each plot, starting from 10th day of sowing to harvest at 10 days interval. After oven drying at 60°C, the dry matter production was determined. The material was powdered in a Wiley mill analysed for its N content with the Microkjeldall method suggested by Humphries(1956). Uptake of N was calculated by multiplying the N content with the quantity of dry matter produced per unit area. Rate of N uptake was worked out by calculating the difference in uptake between two successive periods of sampling. The data obtained were statistically analysed with IBM 1420 computer at the Indian Agricultural Statistics Research Institute, New Delhi.

RESULTS AND DISCUSSION

N content in plants

N content in plants increased slightly from 20th to 30th day of sowing and thereafter there was gradual reduction until harvest (Fig. 1a). As the dry matter production increases, the plant N content will decrease mainly as a result of dilution effect. Raheja and Krantz (1958) and Joshi and Morey (1970) reported similar reduction in the N content of sorghum during the growth period of the crop.



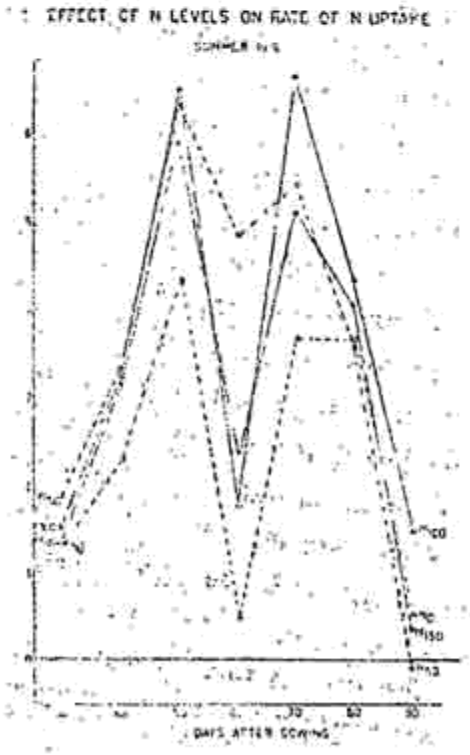
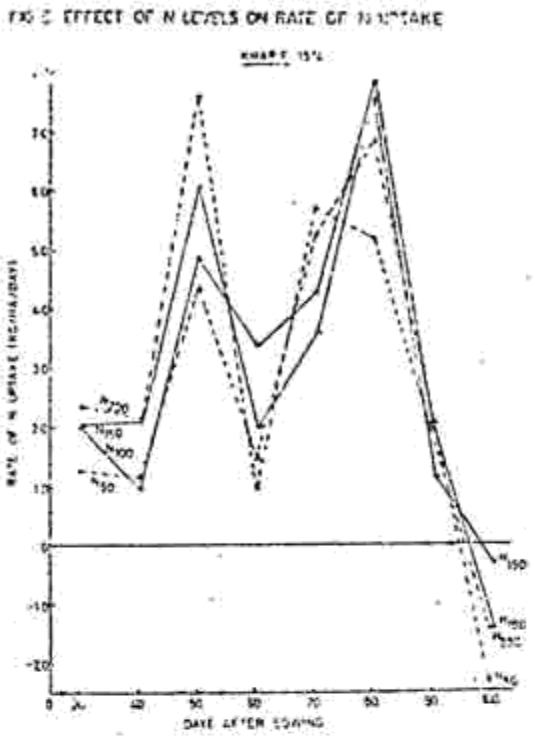


Table 1 Treatment Schedule

Summer, 1974 Treatments	Symbol	*Kharif*, 1974 Treatments	Symbol
Main Plot : Four levels of N		Main Plot : Four levels of N	
0 kg/ha	N_0	50 kg/ha	N_{50}
50 kg/ha	N_{50}	100 kg/ha	N_{100}
100 kg/ha	N_{100}	150 kg/ha	N_{150}
150 kg/ha	N_{150}	200 kg/ha	N_{200}
Sub-plot : Six times of application		Sub-Plot : Five times of application	
All N at planting	T_1	$\frac{1}{5}$ at planting and $\frac{1}{5}$ on 30th day	T_1
$\frac{1}{3}$ at planting, $\frac{1}{3}$ on 40th day	T_2	$\frac{1}{3}$ each at planting, 30th and 45th day	T_3
$\frac{1}{4}$ at planting, $\frac{1}{4}$ each on 26th 52nd and 80th day.	T_3	$\frac{1}{4}$ each at planting, 30th, 45th and 60th day	T_3
$\frac{1}{5}$ each at planting, on 15th, 30th, 45th, 60th and 80th day	T_4	$\frac{1}{5}$ each at planting, 30th, 45th, 60th and 75th day	T_4
$\frac{1}{2}$ each at planting, on 20th, 30th, 40th, 50th, 60th, 70th and 80th day	T_5	Foliar application : $\frac{1}{3}$ at planting through soil and $\frac{1}{3}$ as foliar in equal quantities on 30th, 45th and 60th day	T_5
Foliar application : $\frac{1}{2}$ at planting through soil and $\frac{1}{2}$ through foliage in equal quantities on 40th, 60th and 80th day.	T_6		
Date of sowing :	Feb. 24, 1974		July 20, 1974
Date of harvest :	May 31, 1974		Nov. 1, 1974

Split plot design with 3 replications. Plot size : 4.5 x 3.0 m (Gross)

A common application of 45 kg/ha each of P_2O_5 and K_2O was made to all plots at the time of planting.



N uptake

Uptake of N increased from sowing, the increase being sharp after flowering to physiological maturity (Tables 2 and 3).

After this stage, the uptake decreased slightly. Over 80 per cent of total requirement of N was absorbed before 80 days of sowing. In ***Kharif***, the duration of the crop was extended by about 10 days and so the uptake continued till about 100th day of sowing. Significant increase in N uptake was noticed due to increasing levels of N application. Since N content of the plant was not very much influenced by N levels, the increase in uptake is wholly accounted for by increased dry matter production with increasing N levels. Uptake was lowest in plots receiving no N or lower quantities of N. Tucker and Bennett (1968), Veeranna (1972) and Shrivastava (1969) reported that N uptake in sorghum increased with increasing levels of N application. Time of N application also had a noticeable influence on N uptake. Application of N in four splits through soil (T_3) recorded the highest uptake and the lowest uptake was observed in plots receiving half the quantity of N through soil and the other half through foliage (T_6/T_5). Splitting the dose and applying at critical stages appeared to increase the efficiency of N utilisation. Foliar application coincided with the prevailing high temperature in April and May (34 to 36°C) and this accentuated the scorching effect, especially in higher concentration of N application, as against about 2 percent solution of urea considered safe for foliar application. This probably resulted in a temporary setback in growth thus reducing N uptake.

Total N uptake was higher in *Kharif* than in summer (Fig 1b) This is mainly due to greater dry matter production and consequently higher absorption of N in *Kharif*

Rate of N uptake

Rate of N uptake (Fig. 2 and 3) was lower in the early stages, i. e 20 to 30 days (table 4 and 5). This is because the initial requirement of nutrients is a small as the plant grows rather slowly (Herron ***et al.*** 1963). Thereafter the rate increased, reaching a peak in the 40 to 50 day period (about 6.0 kg / ha / day). This

Table 2. Nitrogen uptake (kg/ha) at various stages of crop growth (means) Summer 1974

Treatments	Days after sowing							
	20	30	40	50	60	70	80	90
Nitrogen levels								
N_0	2.33	17.32	38.62	76.60	97.24	130.98	167 50	159.00
N_{50}	3.20	21.84	54.96	119.71	126.73	193.44	237.47	236.37
N_{100}	2 90	18.50	51.65	108.44	131 86	182 91	223.24	237.46
N_{150}	3.31	17.29	48.13	111.66	159.71	214.02	237.12	240.11
S.E.	0.28	1.54	3.68	7.16	6.76	12.32	5 27	6.87
C. D. (P=0.05)	N.S	N.S	N.S	24.80	23.41	42.66	18.27	23.79
T_1	3.41	14.65	46.88	95.21	130.28	203.83	238.17	233.88
T_2	2.77	19.84	54.10	110.98	131.76	212.50	230.12	233.80
T_3	2.31	19.76	55.17	124.16	151.66	183.86	246.57	262.97
T_4	3.14	20.07	49.25	118.42	148.02	200.34	221.84	246.86
T_5	3.43	21.40	55.93	116.53	137.70	191.96	238.66	240.78
T_6	3.76	19.53	48.13	114.32	137.17	188 25	220.30	209.57
S. E.	0.24	1.64	3.90	7.77	10.37	9.42	10.69	10.26
C. D. (P=0.05)	0.69	N.S	N.S	N.S	N.S	N.S	N.S	29.27
Grand mean	3.14	19.21	51.58	113 27	139.43	196.79	232.61	237.98

Table 3. Nitrogen uptake (kg/ha) at various stages of crop growth (Means) *Kharif* 1974

Treatments	Days after sowing								
	20	30	40	50	60	70	80	90	100
Nitrogen levels									
N_{50}	3.92	16.63	28.20	71.77	87.25	139.97	208.66	229.90	198.72
N_{100}	3.80	24.72	34.71	83.96	109.26	153.15	233.38	251.38	237.94
N_{150}	3.58	24.38	45.44	106.08	125.8 8	161.62	235.38	246.72	243.49
N_{200}	3.85	27.59	49.28	125.08	120.06	177.98	230.32	250.20	233.25
S. E.	0.31	1.32	1.99	4.85	7.06	4.34	4.22	14.16	12.18
C. D. (P=0.05)	N.S	4.62	6.90	16.81	24.46	15.05	14.63	N.S	N.S
Time and method of N application.									
T_1	3.55	26.68	41.31	95.47	109.80	152.65	229.63	251.50	241.52
T_2	3.93	22.09	41.70	93.03	109.80	163.01	220.80	241.09	222.00
T_3	3.85	21.71	39.39	98.12	112. 08	163.97	232.42	249.59	234.10
T_4	3.89	21.10	39.31	97.30	110.50	168.03	229.38	246.67	228.80
T_5	3.70	25.08	35.32	99.70	110.88	143.23	222.43	233.89	215.31
S. E.	0.32	2.00	2.57	6.03	5.52	6.71	6.02	7.19	8.15
C. D. (P=0.05)	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
Grand mean	3.78	23.33	39.41	96.72	110.61	158.18	226.93	244.55	228.35

period concided with the grand growth period of the crop when the root activity would have been very high resulting in greater absorption of N (table 4 and 5). Raheja and Krantz (1958) reported similar high N uptake in the 4th through 7th week. There was a marked reduction in the rate of N uptake at half bloom stage. At this stage, the plant is switching over from vegetative to reproductive phase and so the N requirement would have been low (Raheja and Krantz, 1958). This indicate that N application should be avoided at this stage. After flowering, the rate of uptake again increased reaching a peak in the 60 to 70 day period. At this stage, all the earheads had emerged and so there would have been greater demand for nutrients and photosynthates for grain filling. Roy and Wright (1969) reported a spurt in N uptake at the time of grain filling in CSH.1 sorghum. As the plant neared maturity the uptake slowed down considerably. After physiological maturity there was net loss of N (Negative uptake of N) from the plant in plots receiving low levels or no N. This negative uptake may be attributed to the loss of N either due to fall of senescent leaves or due to translocation from the above ground protion of roots (Berger, 1962 and Roy and Wright, 1974)

Table 4. Rate of Nitrogen uptake (kg/ha/day) at various stages of crop growth (Means) Summer 1974

Treatments	Days after sowing						
	20-30	30-40	40-50	50-60	60-70	70-80	80-90
Nitrogen levels							
N_0	1.312	2.297	4.311	0.492	3.696	3.651	-0.623
N_{50}	1.860	3.809	6.479	1.718	6 656	4.393	-0.109
N_{100}	1.553	3.197	5.928	2.337	5.100	4.033	1.420
N_{150}	1.393	3.137	6.348	4.601	5.430	3.561	0.379
S. E.	0.173	0.434	0.801	0.422	0 563	0.885	0.616
C. D. (P=0.05)	N.S	N.S	N.S	1.462	N.S	N.S	N.S
Time and method of N application							
T_1	1.120	3.063	4.628	3 504	7.348	4.536	-0.427
T_2	1.706	3.423	5 683	2.077	8.067	1.384	0.367
T_3	1.736	3.536	7.390	3 448	3 217	6.643	1.635
T_4	1 690	3.032	6.965	3.645	5 210	3.582	2.662
T_5	1.791	3 447	6.057	2.758	5.424	4.694	0.213
T_6	1.572	2.786	6.586	2.278	5.105	3.195	-1.070
S. E.	0.167	0.406	0.762	1.275	1.459	1.241	1.152
C. D. (P=0.05)	N.S	N.S	N.S	N.S	N.S	N.S	N.S
Grand mean	1.602	3.215	6.252	2.962	5.729	4.006	0.563

Table 5. Rate of Nitrogen uptake (kg/ha/day) at various stages of Crop growth (means) *Kharif* 1974

Treatments	Days after sowing							
	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
Nitrogen levels								
N_{50}	1.244	1.157	4.357	1.460	5.272	6 844	2.139	— 3.156
N_{100}	2.094	1.004	4.918	3.398	4.323	7.898	1.928	— 1.336
N_{150}	2.080	2.106	6.064	1.985	3.572	7.629	1.138	— 0.322
N_{200}	2.374	2.172	7.576	0.974	5.770	5.185	1.996	— 1.409
S. E.	1.414	0.202	0.379	0.769	0.735	0.565	1.511	0.405
C. D. (P=0 05)	0.491	0.702	1.314	N.S	N.S	NS.	N.S	1.406
Time and method of N application								
T_1	2 314	1.465	5 410	1.149	4.204	7.703	2.184	— 0.898
T_2	1.815	1.965	5.127	1.693	5.320	6.353	2 025	— 1.699
T_3	1.753	1.774	5 873	2.740	5.160	6.845	1.723	— 1.544
T_4	1.720	1.822	5.795	2.833	5.750	6.110	1.754	— 1.781
T_5	2.137	1.023	6 438	1 355	3.235	7.438	1.315	— 1.857
S. E.	0.211	0.277	0.621	0 831	0.892	0.823	0.405	0.814
C. D. (P=0.05)	N.S	N.S	N.S	N.S	N.S	N.S	0.922	N.S
Grand mean	1.948	1.610	5 729	1.954	4.734	6 890	1.800	— 1.556

The pattern of rate of N uptake was similar both in summer and *Kharif* seasons except for the shift of the second peak in uptake frnm 60 to 70 days in summer to 70 to 80 days in *Kharif* In *Kharif*, the duration of the crop was extended by about 10 days and this probably delayed the grain filling stage. This resulted in the shift of the second peak in the rate of N uptake curve In summer, neither the levels nor the method of N application had any significant influence on the pattern of rate of N uptake. In *Kharif*, increasing the N application caused a corresponding increase in the rate of N uptake in the early stages. After about 50 days, this difference due to N levels was not noticeable. Time and method of N application had little effect on the rate of N uptake. From this it could be inferred that availability of N from the soil, which is generally higher during warm temperature period, coupled with vigorous growth and greater foraging capacity in summer would have posed no limitation to meet the crop requirement of N and so there was little influence due to applied N. But in *Kharif*, especially in the early stages, when the foraging capacity of the plant was limited and availability of soil N was low application of N had a favourable effect on the absorption.

The results obtained in this study show that a proper N management for sorghum with the objective of

achieving maximum N use efficiency could be developed based on the N uptake pattern of the crop. Besides the started dose to be applied at the time of sowing. N should be applied at early growth phase (30 days), peak vegetative phase (40-50 days) and grain filling phase (60-70 days) for maximum absorption and utilisation of applied N. Application of N should be avoided at the time when the plant is switching over from vegetative to reproductive phase.

The senior author wishes to thank the Indian Council of Agricultural Research for awarding a Junior Research Fellowship for his post-graduate studies, Dr. Y. B. Morachan, thec the Professor and Head of the Agronoms for his kind inspiration and encouragement, and to Tamil Nadu Agricultural University for permitting him to publish his M.Sc. (Agri.) thesis.

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