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Effect of different sources and levels of nitrogen on nutrient uptake by forage chicory (*Cichorium intybus* L.)

D.M. Patel and B.S. Patel

Department of Agronomy, C. P. College of Agriculture,
S. D. Agricultural University, Sardarkurshinagar- 385 506 (Gujarat)

Abstract

A field experiment was conducted Agronomy Instructional Farm, S. D. Agriculural University, Sardarkrushinagar on loamy sand soils during *rabi* seasons of 2002-03 and 2003-04 to study the nutrient uptake, residual soil fertility and yield of forage chicory (*Cichorium intybus* L.) as influenced by various sources of nitrogen. Maximum total green (953.06 q ha^{-1}) and dry forage yield (118.82 q ha^{-1}) were registered with 60 kg N ha^{-1} applied as basal. Similarly, application of 30 kg N ha^{-1} after harvest of each cut turned out superior over 0 and 15 kg N ha^{-1} with respect to total green (1070.7 q ha^{-1}) and dry forage yield (132.28 q ha^{-1})of chicory. Among different levels of N applied as basal, 60 kg N ha^{-1} proved its superiority with respect to N (2.48%) and Ca (2.46 %) content in chicory forage over rest of the treatments. Similarly, application of 30 kg N ha^{-1} after harvest of each cut also recorded significantly higher N and Ca content. However, N applied as basal and as top dress had no effect on P and K content. Maximum removal of N, P and K was noticed under 60 kg N ha^{-1} applied as basal (283.1, 51.2 and 227.4 kg ha^{-1}, respectively) and 318.9, 56.7 and 249.0 kg ha^{-1}, respectively with application of 30 kg N ha^{-1} as top dress after harvest of each cut. However, no improvement in content and uptake of N, P and K was observed with various sources of nitrogen tried in present study.

Key words : Uptake, residual fertility, nitrogen, phosphorus, potash and calcium

Introduction

Gujarat state is pioneer in "White Revolution" in the country. Still the milk productivity is low due to poor health of livestock. This needs to be improved by supplying good quality forage along with feed. Presently lucerne is important fodder crop in North Gujarat region. However, chicory is making headway as supplemental forage crop. Chicory being a non-leguminous multi-cut forage crop. Is highly responsive to nitrogen fertilization (1). Very megre scientific information is available about content and uptake of forage chicory. Keeping this in view, the response of chicory to nutrient uptake and yield as influenced by sources of N and basal as well as top dress application of nitrogen under North Gujarat condition was undertaken.

Material and methods

A field experiment was conducted at Agronomy Instructional Farm, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar during *rabi* seasons of the year 2002-03 and 2003-04. The soil was loamy sand having low in available nitrogen (159.8 kg ha^{-1}), high in available phosphorus (57.5 kg ha^{-1}), medium in available potash (193.6 kg ha^{-1}), low in organic carbon (0.17 %) and pH value of 7.6-7.8. Elecrical conductivity was very low (0.14 dSm^{-1} at 25 °C) showing that the soil was free from salinity hazard. The experiment was laid out in randomized block design with factorial concept. Twenty seven treatment combinations comprising of three sources of nitrogen (S_1: urea, S_2: castor cake and S_3: 50 % N from urea + 50% N from castor cake); three levels of nitrogen (N_1: 20, N_2: 40 and N_3: 60 kg N ha^{-1}) for basal application and three levels of nitrogen (T_0: 0, T_1: 15 and T_2 : 30 kg N ha^{-1}) for top dress application after harvest of each cut. A basal dose of nitrogen (from urea, castor cake and 50% N from urea + 50% N from castor cake) as per treatments and 30 kg P_2O_5 ha^{-1} from single super phosphate was applied before sowing in previously opened furrows as a common dose. Top dress application of nitrogen from urea was made after harvest of each cut as per treatments. The crop was sown on 3rd November, 2002 and 11th November, 2003. Total five cuts were taken from forage chicory.

Nitrogen from plant sample was determined by using Micro Kjeldahl's method (2). The acid extract of plant sample was made by diacid mixture. From this acid extract, phosphorus, potassium and calcium content were estimated by Vanadomolybdo phosphoric acid yellow colour method in HNO_3 system (2), flame photometric method (2) and Versanate titration method (2), respectively.

Castor cake is used as one of the source of nitrogen for basal application. It contains 4.4, 1.81 and 0.47 per cent N, P_2O_5 and K_2O, respectively. To equate the quantity of P_2O_5 and K_2O in rest of the treatment combinations, the deficit quantity of P_2O_5 and K_2O was added in respective treatment combination from SSP and muriate of potash, respectively.

Results and discussion

Effect of sources of nitrogen

Various sources of N failed to induce any improvement in N, P, K and Ca content as well as uptake by forage chicory (Table 1). The removal of total N, P and K were 272.9, 50.5 and 222.6 kg ha^{-1} respectively with the application of 50% N from urea + 50% N from castor cake treatment, which was slightly

Table 1. Nutrient content, uptake and forage yield of chicory as influenced by different sources of nitrogen with levels of nitrogen for basal as well as top dress application (Pooled data of 2002-03 and 2003-04).

Treatments	Nutrient content (%)				Nutrient uptake (kg ha^{-1})			Total forage yield (q ha^{-1})	
	N	P	K	Ca	N	P	K	Green	Dry
Sources of nitrogen									
S_1: Urea	2.45	0.43	2.05	2.41	271.0	49.6	220.9	902.91	115.43
S_2: Castorcake	2.43	0.43	2.05	2.40	272.4	50.4	222.2	888.87	116.96
S_3: 50% N from urea + 50% from castor cake	2.45	0.44	2.05	2.44	272.9	50.5	222.6	917.09	116.01
S. Em. ±	0.01	0.002	0.01	0.01	3.1	0.5	2.5	8.90	1.19
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
Levels of nitrogen (basal)									
N_1: 20 kg N ha^{-1}	2.40	0.43	2.04	2.37	262.8	49.0	215.4	854.44	114.28
N_2: 40 kg N ha^{-1}	2.44	0.44	2.07	2.42	270.1	50.3	222.6	901.37	115.28
N_3: 60 kg N ha^{-1}	2.48	0.43	2.05	2.46	283.1	51.2	227.4	953.06	118.82
S. Em. ±	0.01	0.002	0.01	0.01	3.1	0.5	2.5	8.90	1.19
C. D. at 5%	0.03	NS	NS	0.04	18.7	1.5	6.9	24.67	3.30
Levels of nitrogen (top dress)									
T_0: 00 kg N ha^{-1}	2.37	0.43	2.04	2.37	221.5	41.9	187.9	715.09	96.99
T_1: 15 kg N ha^{-1}	2.43	0.44	2.07	2.42	275.9	52.0	228.5	923.03	119.12
T_2: 30 kg N ha^{-1}	2.53	0.43	2.05	2.46	318.9	56.7	249.0	1070.7	132.28
S. Em. ±	0.01	0.002	0.01	0.01	8.2	1.7	7.0	26.65	3.90
C. D. at 5%	0.03	NS	NS	0.04	50.1	10.2	42.8	162.17	23.74
C. V.%	4.31	7.75	5.08	5.0	9.8	9.2	9.5	8.4	8.69

Table 2. Available N, P_2O_5 and K_2O (kg ha^{-1}) in soil after harvest of forage chicory crop (Pooled analysis of two years)

Treatments	Available nutrients kg/ha.		
	N	P_2O_5	K_2O
Sources of nitrogen			
S_1: Urea	162.3	50.3	176.9
S_2: Castorcake	163.6	51.2	177.6
S_3: 50% N from urea + 50% from castorcake	163.2	50.7	177.8
S. Em. ±	0.9	0.5	0.8
C. D. at 5%	NS	NS	NS
Levels of Nitrogen (Basal)			
N_1: 20 kg N ha^{-1}	162.1	52.0	179.8
N_2: 40 kg N ha^{-1}	163.0	50.6	177.1
N_3: 60 kg N ha^{-1}	164.0	49.6	175.5
S. Em. ±	0.6	0.5	0.8
C. D. at 5%	NS	1.3	2.1
Levels of Nitrogen (Top dress)			
T_0: 00 kg N ha^{-1}	157.8	53.6	186.4
T_1: 15 kg N ha^{-1}	164.5	50.3	176.2
T_2: 30 kg N ha^{-1}	166.7	48.3	169.7
S. Em. ±	0.9	0.5	0.8
C. D. at 5%	2.6	1.3	2.1
C. V.%	4.8	7.8	3.7
Initial status	159.8	57.5	193.6

higher over rest of the treatments. The results are in agreement with those obtained by Tripathi *et al.* (3). Similarly green as well as dry forage yields also remained unaffected due to various sources of nitrogen.

Effect of levels of nitrogen as basal application

Mean N and Ca content in forage chicory was significantly increased with increasing levels of nitrogen. Maximum nitrogen and calcium content (2.48 and 2.46 per cent, respectively) were recorded with 60 kg N ha^{-1} over 20 and 40 kg N ha^{-1}. The increase in N content with the increase in N levels might be due to better availability of nitrogen and its efficient utilization on account of higher leaf area per plant (1). Higher Ca content could be ascribed to a greater cation exchange capacity of roots, as a result of increased nitrogen. There was no appreciable increase in P and K content with increase in levels of nitrogen. Significantly the highest uptake of N (283.1 kg ha^{-1}), P (51.2 kg ha^{-1}) and K (227.4 kg ha^{-1}) was observed under the upper most level of nitrogen application as basal over 20 kg N ha^{-1}, which was to the tune of 7.7, 4.5 and 5.6 per cent, respectively. This could be ascribed to higher dry matter yield recorded at higher N level (60 kg N ha^{-1}). Raju *et al.* (4) reported that N, P and K uptake increased with increase in levels of nitrogen.

Application of 60 kg N ha^{-1}as basal to forage chicory crop significantly increased total green and dry forage yield as compared to 20 kg N ha^{-1}.

Effect of levels of nitrogen as top dress application

Linear response of nitrogen applied after each harvest was observed with respect to mean N and Ca content. An increase in N and Ca content with 30 kg N ha^{-1} was 6.8 and 4.1; 9.6 and 1.7 per cent higher over 0 and 15 kg N ha^{-1}, respectively. This might be due to application of N after each harvest can increase the availability of nitrogen in the soil which satisfies the nutrient requirement of the crop. The increase in Ca content with the amount of applied N might be due

to usual effect of nitrate in increasing total inorganic cations in plants (5). On the other hand P and K content were not significantly influenced due to nitrogen levels. This might be due to dilution effect.

Significantly higher total uptake of N (318.9 kg ha^{-1}), P (56.7 kg ha^{-1}) and K (227.4 kg ha^{-1}) was recorded with 30 kg N ha^{-1} applied after each cut over control which was to the tune of 44.0, 35.3 and 32.5 per cent, respectively. However, treatments N_2 and N_3 were remained at par with each other. The higher uptake of N, P and K might be due to higher green as well as dry forage yield of chicory crop at higher N levels (15 and 30 kg N ha^{-1}) as compared to control (Table 1).

Top dress application of 30 kg N ha^{-1} after harvest of each cut significantly increased green and dry forage yield than control treatment, but it remained at par with 15 kg N ha^{-1}.

Residual soil fertility

Different sources of nitrogen had no significant effect on available nitrogen, phosphorus and potash in soil after harvest of chicory crop (Table 2). With each successive increase in levels of nitrogen (basal) significantly reduced the available P_2O_5 and K_2O in soil and the lowest residual available phosphorus and potash were observed with 60 kg N ha^{-1}. However, nitrogen availability was marginally improved with increase in nitrogen level applied as basal. Similar results were also recorded with respect to top dress application of nitrogen after each harvest. Higher nitrogen level (30 kg ha^{-1}) recorded the lowest available P_2O_5 (48.3 kg ha^{-1}) and K_2O (169.7 kg ha^{-1}); whereas significantly higher available N (166.7 kg ha^{-1}) was noticed as compared to 0 and 15 kg N ha^{-1} (157.8 kg ha^{-1}).

In general, residual available N status was marginally improved (3.2 kg ha^{-1}); whereas available P_2O_5 (6.8 kg ha^{-1}) and K_2O (16.1 kg ha^{-1}) status in soil after harvest of chicory crop was declined to a greater extent as compared to initial status of N (159.8 kg ha^{-1}), P_2O_5 (57.5 kg ha^{-1}) and K_2O (193.6 kg ha^{-1}) in soil irrespective of treatment effect.

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