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EFFECT OF GREEN MANURING ON THE NITRIFYING ACTIVITY OF THE SOIL AND DRY MATTER YIELD OF WHEAT

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In a laboratory study the effect of varying doses of dhancha (*Seshania aculeata*) applied in combination with 200 lbs of N/acre either as ammonium sulphate or as urea on the nitrifying activity of the soil and dry matter yield of wheat was observed. It was noted that nitrogen uptake and dry matter yield increased significantly as the amount of green manure increased as compared to ammonium sulphate or urea applied singly. Maximum recovery of nitrogen occurred where 5 tons/acre green manure was added. Loss of nitrogen occurred by adding green manure, which increased linearly with the green manure dose. Green manure decreased NH_4-N and NO_3-N at the time of sowing, but increased as time after sowing increased as compared to urea or ammonium sulphate applied singly. NO_3-N present in the soil and taken-up by the plants when counted together, was maximum on 120 days after sowing.

INTRODUCTION

The desirability of maintaining or increasing the soil organic matter is well recognized, but in this age of fertilizers, there has been little tendency to look upon the benefits drived from it. However, for a developing country like Pakistan, along with the artificial fertilizers much emphasis should be given on the maintenance of soil organic matter. Organic matter plays a vital role in microbiological, chemical and physical aspects of soil fertility, all of which are important factors in plant responses.

Farmyard manure and green manure are two major sources of organic matter in Pakistan. The supply of farmyard manure is decreasing day by day due to mechanized farming, and hence the importance of green manuring is increasing. Green manuring done for several years with sweet clover significantly increased the yield of corn, field beans, sugar beat, oat and wheat (Davis, 1942). Annual addition of green rye, straw, alfalfa, leaves and manure to sand.

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and clay soils for 20 years tended to increase the mean yields of the crops grown in the field (Halstead and Sowden, 1968). The green manuring done by crops having C:N ratio less than 35 significantly increased the dry matter yield and nitrogen uptake by wheat, whereas, the crops having C:N ratio more than 35 decreased it (Pink and Gaddy, 1948). Release of nitrogen from wide variety of organic materials added to soil was studied and found that materials having nitrogen content more than 2.5% released sufficient nitrogen for crop needs (Parbery and Swaby, 1942). A quick release of nitrogen from the materials containing more than 2.5% nitrogen was reported (Ensminger and Pearson, 1950). Berseem hay (C:N ratio, 14.7) decomposed more rapidly (Gaur *et al.*, 1971). Addition of lupine alongwith ammonium nitrate increased the NO_3-N levels although it resulted in small loss of nitrogen (Gatarta, 1963). The addition of green manure with urea decreased the recovery of total nitrogen (Pink *et al.*, 1945). Similarly, the addition of green manure alongwith ammonium sulphate decreased the nitrogen recovery (Takai *et al.*, 1967a,b). Hussain (1973) found that di-ammonium phosphate was nitrified quicker and was followed by ammonium sulphate and urea in descending order.

So, in this study the effect of varying doses of green manure applied at the time of sowing, supplemented with 200 lbs N/acre either as ammonium sulphate or as urea and 100 lbs P_2O_5/acre on the dry matter yield, nitrogen uptake, nitrification and nitrogen recovery by wheat was studied.

MATERIALS AND METHODS

The work reported was carried out in Soil Science Laboratories, University of Agriculture, Lyallpur during 1973-74. Twenty five lbs of normal sandy clay loam soil of pH, 1.78; ECe.x10^3, 1.78; total nitrogen, 0.04%; saturation percentage, 32; and cation exchange capacity, 7.9 me/100 gm of soil was taken in glazed pots. Green manuring by dhancha (Sesbania aculeata) having C:N ratio 17.5 at the rates of 0, 5, 10, 15 and 20 tons/acre*, nitrogen in one set as urea and in other as ammonium sulphate at the rate of 200 lbs N/acre* and 100 lbs P_2O_5/acre* as triple super-phosphate to each pot were added and mixed with dry soil and then pots were watered before sowing. When the soil came to "vattar" i.e., November 19, 1973, wheat variety "Chenab 70" was sown. Water was applied regularly according to the needs of the crop. The crop was harvested after 30, 60, 90 and 120 days after sowing. The plant material was first air dried, then oven dried at 65°C and the dry matter yield was recorded. The plant samples were ground in grinding mill and analysed for total nitrogen

*Acre means 2 million lbs of soil.

by micro-Kjeldahl method (Jackson, 1958). Soil samples at the time of sowing and at each harvesting time were collected and total nitrogen, NH_4-N and NO_3-N were estimated according to Jackson (1958) and NO_2-N according to Prince (1945). N uptake was calculated by multiplying the dry wt/pot by its N contents.

RESULTS AND DISCUSSION

The results (Table 1) indicate that dry matter yield of wheat was highly influenced by the green manure application and time intervals. All the doses of green manure increased the dry matter yield significantly as compared to control. The increase in dry matter yield was proportionate to the increase in the dose of green manure and the differences among green manure doses were highly significant. At all the time intervals 20 tons/acre green manure have given the highest and control the lowest dry matter yield. Other doses were inbetween control and 20 tons/acre green manure. Ammonium sulphate gave slightly higher yield than urea, but differences due to them were insignificant. Differences due to time intervals, i.e., 30, 60, 90 and 120 days, were highly significant among themselves. The highest dry matter yields from ammonium sulphate and urea applied in combination with 20 tons/acre green manure were 104.51 and 104.35 gms/pot respectively, on 120 days of sowing, and were approximately 66.2% more than control. The increased dry matter yield by green manure as compared to inorganic-N sources and by higher green manure doses compared to lower doses might be due to its narrow C:N ratio; which instead of immobilizing the inorganic nitrogen may have released its own nitrogen and hence had given higher dry matter. Similar results were reported by Davis (1942), Pink and Gaddy (1948) and Halstead and Sowden (1968).

The effect of green manuring on the nitrogen uptake revealed that all the doses of green manure increased nitrogen uptake (Table 2) significantly than check and the increase in uptake was proportionate to the increase in the dose of the manure. The differences due to green manure doses were significant among-themselves. The uptake on 30 days was not much affected by green manure doses but at 60, 90 and 120 days the uptake of nitrogen increased with an increase in the time interval, and each time interval was significantly different than the other. The nitrogen uptake was slightly more where green manure was applied in combination with ammonium sulphate as compared to urea, but differences were insignificant. The increased uptake by the addition of green manure might be due to increased rate of mineralization (Parbery and Swaby, 1942; Ensminger and Pearson, 1950; and Gaur *et al.*, 1971). The recovery of nitrogen increased by the application of 5 tons/acre green manure but increasing doses of green manure decreased it. The nitrogen recovery

Table 1. *Effect of green manuring on dry matter yield of wheat* (results are gms/pot and average of three repeats).

Time intervals days	Green manure tons/acre				
	0	5	10	15	20
N–200 lbs as ammonium sulphate					
30	1.08	1.05	1.06	1.18	1.28
60	8.02	10.08	12.05	13.68	15.85
90	28.77	35.15	38.12	41.77	47.62
120	62.85	76.20	87.31	91.45	104.51
N–200 lbs as urea					
30	1.07	1.04	1.06	1.12	1.23
60	7.53	9.61	11.95	13.33	15.82
90	28.35	34.77	37.86	41.52	47.42
120	62.65	75.62	87.15	91.22	104.35

Table 2. *Effect of green manuring on nitrogen uptake by wheat* (results are gms/pot and average of three repeats).

Time intervals days	Green manure tons/acre				
	0	5	10	15	20
N–200 lbs as ammonium sulphate					
30	0.062	0.060	0.061	0.068	0.076
60	0.363	0.474	0.601	0.710	0.848
90	1.022	1.272	1.452	1.598	1.934
120	1.527	1.985	2.302	2.481	2.957
N–200 lbs as urea					
30	0.061	0.058	0.061	0.065	0.073
60	0.342	0.449	0.595	0.689	0.842
90	0.998	1.252	1.431	1.578	1.916
120	1.516	1.958	2.292	2.472	2.932

for 0, 5, 10, 15 and 20 tons/acre green manure were 25.8, 26.0, 24.5, 23.2 and 22.8% respectively at 120 days after sowing. Time interval showed positive effect and nitrogen recovery increased with increasing time interval. Maximum nitrogen recovery was at 120 days and minimum at 30 days of time interval. Recovery was slightly more in case of ammonium sulphate as compared to urea. The decreased recovery of nitrogen with increasing doses of green manure might be due to higher undecomposed material which took longer time for decomposition than the lower doses. The nitrogen losses increased by increasing the dose of green manure, and were 0.2, 2.6, 5.1 and 7.5% for 5, 10, 15 and 20 tons/acre green manure respectively at 120 days after sowing. Results are in agreement with Gatarta (1963), Pink (1945) and Takai *et al.* (1967).

The application of green manure decreased the NH_4-N (Tables 3 & 4) as compared to ammonium sulphate and urea at the time of sowing and the decrease was proportionate to the amount of green manure, but on 30, 60, 90 and 120 days opposite trend was observed i.e., NH_4-N increased with increasing the amount of green manure although the total NH_4-N decreased significantly with increasing time interval. The decrease in NH_4-N with time was due to its nitrification. The differences due to urea and ammonium sulphate were non-significant. The increased NH_4-N with increasing doses of green manure might be due to mineralization of organic nitrogen of green manure. Results are in full accordance with those of Gatarta (1963). NO_3-N (Tables 3 & 4) increased by the application of green manure as compared to inorganic-N sources and as the dose of green manure increased the NO_3-N increased as compared to respective lower dose at all sampling times. NO_2-N increased in all the doses at 30 days after sowing. As the incubation time increased the NO_2-N decreased till they disappeared on 90 days in 0 and 5 tons and on 120 days in 0, 5 and 10 tons, but persisted in 10, 15 and 20 tons on 90 days and in 15 and 20 tons of green manure on 120 days though in small amounts. Urea and ammonium sulphate had shown similar results. Higher amount of NO_2-N due to higher doses of green manure may be due to higher NH_4-N mineralized from organic nitrogen present in them which persisted upto 120 days. It can also be postulated that the activities of *Nitrosomonas* and *Nitrobacter* were not the same. NO_3-N (Tables 3 & 4) at the time of sowing was more where inorganic-N alone was applied and it decreased with increasing the amount of green manure. On incubation NO_3-N increased by the application of green manure upto 60 days but in control it was maximum on 30 days after sowing. In green manure after 60 days and in control after 30 days

Table 3. *Effect of green manuring applied in combination with ammonium sulphate on nitrifying activity of the soil.*

Time intervals days	Green manure tons/acre				
	0	5	10	15	20
Total-N in soil (ppm)					
0	520	670	830	980	1140
30	510	660	820	970	1130
60	480	620	770	910	1060
90	420	550	690	820	920
120	390	500	630	730	830
NO_3-N in soil (ppm)					
0	35	33	32	32	30
30	50	52	52	54	56
60	37	59	67	75	86
90	27	38	43	49	58
120	19	24	27	30	36
NO_2-N in soil (ppm)					
0	2	3	5	5	4
30	6	7	10	13	15
60	4	4	6	7	11
90	0	0	2	5	7
120	0	0	0	2	3
NH_4-N in soil (ppm)					
0	96	93	90	91	89
30	62	61	63	64	66
60	31	33	35	38	41
90	23	24	24	26	27
120	15	16	16	18	19
NO_3-N in soil+taken by the crop (ppm)					
0	35	33	32	32	30
30	56	58	58	60	63
60	69	102	121	138	162
90	118	152	172	191	230
120	154	200	232	251	299

Table 4. *Effect of green manuring applied in combination with urea on the nitrifying activity of the soil.*

Time intervals days	Green manure tons/acre				
	0	5	10	15	20
Total-N in soil (ppm)					
0	520	660	820	980	1130
30	500	650	810	970	1120
60	470	630	760	900	1070
90	430	560	700	830	930
120	390	500	610	730	830
NO_3-N in soil (ppm)					
0	31	30	28	27	26
30	52	51	53	54	57
60	58	60	66	75	85
90	28	40	42	50	58
120	18	25	28	29	37
NO_2-N in soil (ppm)					
0	0	2	4	3	5
30	4	7	10	13	14
60	3	5	7	6	10
90	0	2	0	5	6
120	0	0	0	2	4
NH_4-N in soil (ppm)					
0	93	91	91	89	87
30	62	63	65	66	68
60	33	34	36	37	42
90	23	24	23	27	29
120	15	17	18	20	21
NO_3-N in soil + taken by the crop (ppm)					
0	31	30	28	27	26
30	57	56	58	60	64
60	68	100	119	136	160
90	117	151	169	190	228
120	152	199	232	249	297

NO_3-N content of the soil started decreasing and went on decreasing till 120 days. Ammonium sulphate and urea behaved similarly and did not differ significantly from each other. The increase in NO_3-N during early stages might be due to greater nitrification of NH_4-N/mineralization of organic-N and/less uptake by the crops and hence the decrease at latter stages might be due to greater uptake by crops and less NH_4-N/mineralized-N from green

manure. Nitrification had not stopped at any stage and NH_4-N remained available even where no green manure was applied. Similar results were reported by Gatarta (1963) and Hussain (1973). If we sum up the NO_3-N in the soil and NO_3-N taken up by crops (assuming that all the nitrogen taken by plants was in NO_3 form) it is clear (Tables 3 & 4) that nitrate formation continued and maximum NO_3-N was on 120 days after sowing irrespective of the source and dose. The maximum NO_3-N was where 20 tons green manure and minimum where inorganic fertilizers alone were applied and the remaining doses were inbetween according to the amount of green manure. In fallow lands it had been reported by some workers that nitrate formation stopped after certain time, although the NH_4-ions were present, whereas, under crops as NO_3 were continuously consumed by the plants the NO_3 formation continued till the end of NH_4-ions.

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