International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(4): 3292-3295

Received: 03-05-2018
Accepted: 07-06-2018

Gyan Prakash Pandey
M.Sc. (Ag), Department of Soil Science and Agricultural Chemistry, College of Agriculture, Indore, Madhya Pradesh, India

UR Khandkar
Cheif Scientist, SAS Project, College of Agriculture, Indore, Madhya Pradesh, India

SC Tiwari
Senior Technical Officer, Soil Testing Service Scheme, College of Agriculture, Indore, Madhya Pradesh, India

Narendra Kumawat
Scientist (Agronomy), SAS Project, College of Agriculture, Indore, Madhya Pradesh, India

Correspondence
Narendra Kumawat
Scientist (Agronomy), SAS Project, College of Agriculture, Indore, Madhya Pradesh, India

Productivity, profitability of wheat and soil fertility as influenced by different levels of nitrogen under SODIC vertisols

Gyan Prakash Pandey, UR Khandkar, SC Tiwari and Narendra Kumawat

Abstract
An field experiment was carried out during the *rabi* season of 2012-13 to study the effect of nitrogen levels on productivity and profitability of wheat (*Triticum aestivum* L.) under sodic Vertisols at Salinity Research Farm, Barwaha, Indore (MP). Six levels of nitrogen *viz*., 0, 30, 60, 90, 120 and 150 kg ha^{-1} was laid out in randomized block design with four replications. The results showed that increasing levels of nitrogen significantly increased the yields, economics, N content, uptake, protein content and available N in soil when compared to control. Among the different levels of nitrogen, application of 150 kg N ha^{-1} produced highest grain yield (35.89 q ha^{-1}), straw yield (48.85 q ha^{-1}), N content (2.02% in grain and 0.40% in straw), N uptake (72.49 by grain and 19.60 by straw kg ha^{-1}) and protein content (12.63%). Significantly higher gross return (Rs. 64896 ha^{-1}), net returns (Rs. 40515 ha^{-1}), B: C ratio (1.66) and available N in soil (173.10 kg ha^{-1}) were recorded in 150 kg N ha^{-1} over control. The highest N use efficiency (10.94 kg grain kg^{-1} N) and lowest recovery of N (37.41%) was noted with highest levels of nitrogen i.e. 150 kg ha^{-1}. Different levels of nitrogen did not influence the pH, ESP, EC and organic carbon status of the soil.

Keywords: Economics, N use efficiency, N uptake, protein content, soil fertility, wheat, yields

Introduction

Soil salinity and sodicity are the threat for crop production, particularly in irrigated and semi-arid regions. Higher evaporation and lower rainfall are responsible for inadequate leaching and consequently the accumulation of salts in the root zone. Excessive salts in the root zone usually adversely affect nutrient uptake by plants resulting in some physiological disorders and accumulation of toxic ions in the tissue. The high sodicity causes clay to swell excessively when wet. The clay particles move so far apart that they separate (disperse). This weakens the aggregates in the soil, causing structural collapse and closing-off of soil pores. Therefore, water and air movement through sodic soils is severely restricted. Sodicity of the surface soil is likely to cause dispersion of surface aggregates, resulting in surface crusts. Wheat is one of the major global cereal crops, ranking 2nd after paddy in area and production and provides more nourishment than any other food crop (Maurya *et al*. 2014 and Hailu *et al*. 2017) [12, 8]. Optimal rates of fertilizer application to salt-affected soils partially alleviate the adverse effects of salinity on photosynthesis and photosynthesis-related parameters and yield components through mitigating the nutrient demands of salt-stressed plants (Sultana *et al*., 2001) [22].

The key role of N fertilizers has played in increasing crop yields as well improves the quality of grain and straw in wheat (Zemichael *et al*. 2017) [25]. Nitrogen comprises 7% of total dry matter of plants and is a constituent of many fundamental cell components such as nucleic acids, amino acids, enzymes, and photosynthetic pigments However, reports have shown that about 50% of applied N fertilizer remains unavailable to a crop due to temporary immobilization in soil organic matter or due to losses by leaching, erosion nitrification or volatilization (Zafar and Muhammad, 2007) [24]. Application of nitrogen plays significant role for boosting up wheat yield from salt-affected soils. The proper use of N fertilizer in all soil is important, but particularly in saline soils, where N may minimize the adverse effects of salinity on plant growth and yield depending on plant species, salinity level, or environmental conditions (Irshad *et al*. 2002, Abdelgadir *et al*. 2005, Elgharably *et al*. 2010 and Elgharably, 2011) [2, 9, 6, 7]. Literature indicated that yield and nutrient content, uptake and economics affected with the application of nitrogen on salt affected soils (Elgharably, 2011) [7].

Keeping this information, a study was planned to effect of levels of nitrogen on wheat production, nutrient uptake, economics and chemical properties of sodic Vertisols.

Materials and Methods

The field experiment was carried out during winter (*rabi)* season of 2012-13 on sodic Vertisols at Salinity Research Farm, Barwaha, Indore. The soil properties of the field were: alkaline 8.56, EC 1.38 dS m^{-1}, Ca^{++} 14.0 cmol (p+) kg^{-1}, cation exchange capacity 36.4 cmol (p+) kg^{-1}, exchangeable sodium percentage 25, available N 168 kg ha^{-1} and K_2O 390 kg ha^{-1}. The experiment was designed in randomized block design with four replicates. Nitrogen levels @ 0, 30, 60, 90, 120 and 150 kg ha^{-1}) was applied in respective treatments at the time of sowing. A uniform application of 60 kg P and 40 kg K ha^{-1} was applied to all the plots. The wheat variety HI-1077 was sown at row spacing 22x5cm on 30th November 2012 and harvested on 23th March 2013. The plots were harvested and the total grain and straw yields were recorded in kg $plot^{-1}$ then converted into q ha^{-1}. Gross return was calculated based on the local market prices. Net return was computed by subtracting cost cultivation from gross returns. Benefit cost ratio is the ratio of net returns to cost of cultivation. It is expressed as net returns per rupee invested.

Plant samples, which was taken after harvesting of crop, was separated into grains and straw and air dried weights of grains and straw were taken plot wise. All samples were oven dried and finally ground, and stored in plastic bags for chemical analysis. The nitrogen in plants were analysed as per standard methods (Piper, 1967) [15]. Surface soil samples (0-15 cm depth) from each plot were taken before sowing and after harvest and prepared for chemical analysis. Nitrogen content was determined by alkaline permanganate method as suggested by Subbiah and Asija (1956) [21]. Protein concentration was calculated from the volume of total nitrogen after multiplied by 6.25 according (AOAC, 1980) [1]. Apparent nitrogen recovery of fertilizer (%) was calculated for each treatment according to the following equation (Crasswell and Godwin, 1984) [5].

$$\text{Recovery of N fertilizer (\%)} = \frac{\text{N uptake from fertilized plot-N uptake from control plot}}{\text{N applied through fertilizer}} \text{ X } 100$$

$$\text{N use efficiency} = \frac{\text{Grain yield in fertilized plot-grain yield in control plot}}{\text{Nitrogen application}}$$

Data collected during the study were statistically analyzed by using the technique of analysis of variance (ANOVA) described by Panse and Sukhatme (1967) [14]. To judge the significant difference between means of two treatments, the critical difference (CD) was worked out (P=0.05).

Results and Discussion

Grain and straw yield

Data revealed that grain and straw yield was significantly influenced by various nitrogen levels (Table 1). It is clear from the data that highest grain yield of 35.89 q ha^{-1} and straw yield of 48.85 q ha^{-1} was noted for plots treated with 150 kg N ha^{-1}, while minimum (19.48 and 31.12 q ha^{-1}, respectively) in control plot. The magnitude of grain and straw yield increased owning to direct application of N with 150 kg ha^{-1} were 84.24 and 56.97 per cent over control, respectively. Other levels of nitrogen also proved superiority as compared to control. The higher grain and straw yield was obtained in higher level of nitrogen might be due to application of higher dose of nitrogen, which increased the photosynthetic activity of the plants and might have increased vegetative growth and yield attributes like that spike length and ultimately resulted into higher number of grains spike which increases grain and straw yield. Similar results on yield attributes and yields were also reported by Shirazi *et al*. (2014) [18] and Shah *et al*. (2015) [17].

N content and uptake

The nitrogen content and uptake by grain and straw was affected significantly with the increasing levels of nitrogen over control (Table 1). Higher nitrogen content in grain and straw (2.02% in grain and 0.10% in straw) was noted in 150 kg N ha^{-1}, while minimum N was in control (1.38 and 0.29%). Similarly, highest N uptake by grain (72.49 kg ha^{-1}) and straw (19.60 kg ha^{-1}) as well as total N uptake (92.09 kg ha^{-1}) were also recorded with the application of 150 kg N ha^{-1}. However, the lowest values of these parameters were noted in control plot where no N fertilizer applied (26.86, 9.11, and 35.97 kg ha^{-1}, respectively). The maximum protein content (12.63%) was also observed in 150 kg N ha^{-1} which was significantly higher by 46.34 per cent over control. This might be due to higher level of nitrogen application provides congenial surrounding for better root growth and distribution. This enhances the scope to explore the nutrients from the greater soil volume. The excess salt in soil might have caused a decrease in total N uptake by plants. But, increase in application of nitrogen significantly enhanced the N uptake by plants. These results are in conformity with Abid *et al*. (2002) [3], Chaturvedi (2006) [4], Raval (2013) [16] and Shah *et al*. (2015) [17].

N use efficiency and recovery of N

The data of N use efficiency and recovery of N (%) was given in table 1. Significantly higher N use efficiency (10.94 kg grain kg^{-1} N) was recorded with the application of 150 kg N ha^{-1} but it was found at par with 120 kg N ha^{-1} when compared to control. The lowest recovery of N (37.71%) was obtained with the application 150 kg N ha^{-1}, however, it was statistically similar with 120 and 90 kg N ha^{-1}. The maximum N use efficiency (16.86 kg grain kg^{-1} N) and lowest recovery of N (50.56) was observed in 30 kg N ha^{-1}. The nitrogen use efficiency (NUE) depends of the water availability. NUE significantly increased with increase N fertilization level than control. While recovery of N reduced in highest N level. This can be attributed to N loss in ecosystem. Somarin *et al*. (2010) [20], Noureldin *et al*. (2013) [13], Mandic *et al*. (2015) [11] and Zemichael *et al*. (2017) [25] were also reported that increased N level reduced NUE.

Table 1: Yields, N content, uptake, N-use efficiency and recovery of N as influenced by different levels of nitrogen under sodic Vertisols

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	N content in grains (%)	N content in straw (%)	Protein content in grains (%)	N uptake by grain (kg ha^{-1})	N uptake by straw (kg ha^{-1})	Total N uptake (kg ha^{-1})	N use efficiency (kg grain kg^{-1} N)	Recovery of N (%)
Control	19.48	31.12	1.38	0.29	8.63	26.86	9.11	35.97	-	-
30 kg N ha^{-1}	24.53	36.76	1.59	0.33	9.91	38.87	12.27	51.14	16.86	50.56
60 kg N ha^{-1}	29.07	43.98	1.63	0.35	10.21	47.52	15.51	63.04	15.98	45.10
90 kg N ha^{-1}	32.08	45.17	1.73	0.38	10.81	55.51	17.34	72.85	14.00	40.97
120 kg N ha^{-1}	33.77	46.67	1.83	0.39	11.36	61.42	18.41	79.84	11.91	36.55
150 kg N ha^{-1}	35.89	48.85	2.02	0.40	12.63	72.49	19.60	92.09	10.94	37.41
SEm±	0.55	0.67	0.03	0.01	0.18	1.36	0.29	1.48	0.75	1.99
CD (P=0.05)	1.64	2.01	0.09	0.02	0.54	4.09	0.87	4.47	2.27	6.01

Table 2: Economics and chemical properties of soils as influenced by different levels of nitrogen under sodic Vertisols

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C Ratio	pH	ESP	EC dSm^{-1}	Organic carbon (%)	Available N (kg ha^{-1})
Control	19856	36603	16747	0.84	8.54	24.10	1.35	0.288	157.28
30 kg N ha^{-1}	20881	45378	24497	1.17	8.53	24.00	1.38	0.290	161.30
60 kg N ha^{-1}	22006	53886	31880	1.45	8.52	23.90	1.39	0.293	164.95
90 kg N ha^{-1}	22831	58462	35631	1.56	8.50	23.90	1.40	0.295	166.35
120 kg N ha^{-1}	23656	61283	37627	1.59	8.50	23.90	1.41	0.300	171.00
150 kg N ha^{-1}	24381	64896	40515	1.66	8.50	23.90	1.41	0.305	173.10
SEm±	-	-	-	0.84	0.15	0.063	0.17	0.006	2.03
CD (P=0.05)	-	-	-	1.17	NS	NS	NS	NS	6.12

Economics

Data presented in table 2 indicated that economic analysis of wheat as affected by different levels of nitrogen. Among the various levels of nitrogen, the maximum gross return (Rs. 64,896 ha^{-1}), net return (Rs. 40,515 ha^{-1}) and benefit cost ratio (1.66) were recorded under 150 kg N ha^{-1} followed by treatment 120 kg N ha^{-1} which recorded the gross returns (Rs. 61,283 ha^{-1}) and net returns (Rs. 37,627 ha^{-1} with 1.59 B:C ratio. Control treatment registered minimum gross return (Rs. 36,603 ha^{-1}), net return (Rs. 16,747 ha^{-1}) and B: C ratio (0.84). The highest dose of nitrogen produced maximum grain and straw yield that positively correlated with economics. These results obtained in the present investigation are in accordance with those reported by Suryawanshi *et al*. (2013) [23].

Soil Fertility

Chemical properties of soil (pH, ESP, EC, organic carbon and available N) were influence by different levels of nitrogen (Table 2). Application of nitrogen did exert significant variation in pH, ESP, EC and organic carbon. Similarly, application higher doses of nitrogen, the available N in the soil was observed to be higher than lower doses of nitrogen, which might be due to considerable gain of nitrogen content in the soil with its addition. The maximum value of available N in soil was noted at 150 kg N ha^{-1} which was on par with 120 kg N ha^{-1}, its indicated beneficial effect of N on their availability. These results are in conformity with those reported by Singh *et al*. (2013) [19].

References

1. AOAC. Association of Official Agriculture chemists. (Official Methods of Analysis), 13th Ed., Washington, D.C, 1980.
2. Abdelgadir EM, Oka M, Fujiyama H. Characteristics of nitrate uptake by plants under salinity. J Plant Nutr. 2005; 28:33-46.
3. Abid M, Ahmad F, Ahmad N, Ahmad I. Effect of phosphorous on growth, yield and mineral composition of wheat in different textured saline-sodic soils. Asian J Plant Sci. 2002; 1(4):472-475.
4. Chaturvedi I. Effects of different nitrogen levels on growth, yield and nutrient uptake of wheat (*Triticum aestivum* L.). Intern J Agric Sci. 2006; 2(2):372-374.
5. Crasswell ET, Godwin DC. The efficiency of nitrogen fertilizers applied to cereals in different climates. Adv Plant Nutri. 1984; 1:1-55.
6. Elgharably A, Marschner P, Rengasamy P. Wheat growth in a saline sandy loam soil as affected by N form and application rate. Plant Soil. 2010; 328:303-312.
7. Elgharably A. Wheat response to combined application of nitrogen and phosphorus in a saline sandy loam soil. Soil Sci Plant Nutri. 2011; 57(3):396-402.
8. Hailu H, Mamo T, Keskinen R. Response of wheat (*Triticum aestivum* L.) to phosphorus and potassium fertilization on vertisols in Ethiopia's central Highlands. E-ifc. 2017; 48:15-44.
9. Irshad M, Honna T, Eneji AE, Yamamoto S. Wheat response to nitrogen source under saline conditions J Plant Nutri. 2002; 25:2603-2612.
10. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Ltd. New Delhi, 1967.
11. Mandic V, Krnjaja V, Tomic Bijelic Z, Simic A, Muslic DR, Gogic M. Nitrogen fertilizer influence on wheat yield and use efficiency under different environmental conditions. Chilean J Agric Res. 2015; 75(1):92-96.
12. Maurya P, Kumar V, Maurya KK, Kumawat N, Kumar R, Yadav MP. Effect of potassium application on growth, yield and economics of wheat varieties. The Bioscan. 2014; 9(4):1371-1373.
13. Noureldin NA, Saudy HS, Ashmawy F, Saed HM. Grain yield response index of bread wheat cultivars as influenced by nitrogen levels. Ann Agric Sci. 2013; 58:147-152.
14. Panse VG, Sukhatma PV. Statistical methods for agricultural workers. ICAR, New Delhi, 1967, 67-69.
15. Piper CS. Soil and Plant Analysis. Asian Publishing House, Bombay and New Delhi, 1967, 85-102.

16. Raval R. Response of maize (*Zea mays* L.) to graded doses of nitrogen under varying levels of soil salinity in vertisol of Ghataprabha command area. M.Sc. (Ag). Thesis submitted to Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dharwad University of agricultural sciences, Dharwad, 2013.
17. Shah KA, Tandel BM, Bhimani GJ. Growth, yield and nutrient contents and uptake by wheat as influenced by different residue management practices and nitrogen levels. Intern J fore Crop Imp. 2015; 6(1):64-70.
18. Shirazi SM, Yusop Z, Zardari NH, Ismail Z. Effect of irrigation regimes and nitrogen levels on the growth and yield of wheat. Adv Agric. 2014; 2014:1-6.
19. Singh V, Singh SP, Singh S, Shivay YS. Growth, yield and nutrient uptake by wheat (*Triticum aestivum*) as affected by bio fertilizers, FYM and nitrogen. Indian J Agric Sci. 2013; 83(3):331-334.
20. Somarin SJ, Mahmoodabad RZ, Yari A, Khayatnezhad M, Gholamin R. Study of agronomical nitrogen use efficiency of durum wheat affected by nitrogen fertilizer and plant density. World Appl Sci J. 2010; 11:674-681.
21. Subbia BV, Asija GL. A rapid procedure for the determination of available nitrogen in soils. Curr Sci. 1956; 25:259-260.
22. Sultana N, Ikeda T, Kashem MA. Effect of foliar spray of nutrient solutions on photosynthesis, dry matter accumulation and yield in seawater-stressed rice. Environ Expt Bot. 2001; 46:129-140.
23. Suryawanshi PK, Patel JB, Kumbhar NM. Yields and economics of wheat (*Triticum aestivum* L.) influenced by SWI techniques with varying nitrogen levels. Intern J Agric Sci. 2013; 9(1):305-308.
24. Zafar J, Muhammad FC. Effects of soil and foliar application of different concentrations of NPK and foliar application of $(NH_4)_2SO_4$ on growth and yield attributes in wheat (*Triticum aestivum* L.). Pakistan J Plant Sci. 2007; 13(2):119-128.
25. Zemichael B, Dechassa N, Abay F. Yield and nutrient use efficiency of bread wheat (*Triticum Aestivum* L.) as influenced by time and rate of nitrogen application in Enderta, Tigray, Northern Ethiopia. Open Agric. 2017; 2:611-624.
https://doi.org/ 10.1515 /opag-2017-0065.