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Research Paper

Tillage, crop residue management and nitrogen application impacts on soil properties under maize–wheat (*Zea mays–Triticum aestivum*) cropping system

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ABSTRACT

Tillage intensity, crop residue retention and nitrogen application can significantly impact the soil properties and crop productivity. We studied the effect of tillage (deep tillage [DT] vs. shallow tillage [ST]) in main plots and residue management viz. conventional tillage without residue (CT-R), conventional tillage with residue (CT+R), minimum tillage without residue (MT-R) and minimum tillage with residue (MT+R) in sub plots and fertilizer-N at 75, 100 and 125% N (viz. N_{75}, N_{100} and N_{125}) in sub-sub plots. Field treatments were established in maize-wheat (*Zea mays-Triticum aestivum*) cropping system during 2016-2019 at two different locations in north-western India and were arranged in split-split plot design. The soil penetration resistance was significantly lower under deep tillage (3.4 to 3.7%) as compared to shallow tillage. CT+R recorded lowest penetration resistance as compared to other tillage and residue combinations but other soil properties like OC, available NPK, soil aggregation, infiltration rate did not differ significantly. The addition of crop residue both under minimum and conventional tillage significantly increased the soil microorganism count and dehydrogenase enzyme activity at both locations. CT-R recorded lowest microorganism count and dehydrogenase enzyme activity. The available soil nitrogen, microorganism count and dehydrogenase enzyme activity significantly increased with increasing nitrogen doses at both locations and were highest under 125% N level as compared to 75% and 100% levels. In both crops, the grain yield was not significantly affected by tillage and crop residue combinations while the different levels of nitrogen fertilizer significantly affected the grain yield. From soil health and sustainability point of view, CT+R treatment with 100% recommended dose of nitrogen in maize-wheat crop rotation seemed beneficial.

Key words: Deep tillage, Crop residue, Nitrogen, Maize-Wheat cropping system, Soil properties

Maize (*Zea mays*)–wheat (*Triticum aestivum*) is one of the prominent cropping systems followed by farmers of Punjab state. However, rice–wheat cropping system occupies largest share of cropping area, but rice is not the native crop of this area is depleting the underground water resource of the region (Bhatt *et al.*, 2021). Maize has the potential to diversify the area under rice. In general, crops such as maize, rice and wheat are input intensive and incur higher cost on inputs like field preparation and fertilization, which reduces the profitability of the farmers (Singh *et al.*, 2021). Thus, there is a need to manage this cropping system optimally so as to reduce expenditure and increase profitability. Conservation tillage is an important technique which can save time, resource and money, without losing crop productivity besides sustaining natural resources (Singh and Benbi, 2021). Conventional tillage which may require 4–6 number of tillage operations consumes a large proportion of total operational cost and energy. While zero tillage (ZT) can help to eliminate this extra burden without compensating grain yield. Residue decomposition in ZT system can have beneficial effects on soil physical, chemical and biological properties (Ram *et al.*, 2013). Deep tillage is helpful in breaking the hard pan, facilitating the aeration of lower layers and refreshing the soil structure by mixing the top and bottom soils (Singh *et al.*, 2020). Ghuman and Singh (2023) reported significantly higher grain yield of maize in heavy textured soils under deep tillage treatment. There have been other studies on effect of tillage and other factors on crop productivity in rice, wheat and maize based cropping systems (Yadav *et al.*, 2015; Yadav *et al.*, 2005; Kumar and Yadav, 2005; Tripathi and Chauhan, 2001). Crop residue management may be considered as an important component of sustainable agriculture. It can help in improving nutrient status and organic matter of the soil, in addition to eliminating the pollution and other degenerative effects caused by residue burning

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(Sharma *et al.*, 2021). Nonetheless, crop residue management has significant impact on soil physical, chemical, biological, microbiological and enzymatic properties, which largely impacts ecosystem's sustainability as well as economic returns to the farmers. The crop residue management can be done through incorporation, mulching with minimum or zero tillage or by collecting and removing the residue for some other constructive alternate use (Singh *et al.*, 2020). The nitrogen (N) application in residue retained fields is a complex phenomenon (Sharma *et al.*, 2021). The N deficiency caused due to the immobilization of fertilizer and soil N during the initial period of residue decomposition can have negative effects on wheat yield (Sharma *et al.*, 2021). The adverse effects of N immobilization can be neutralized by providing extra dose of N or extra time for the decomposition of crop residue before planting of next crop (Sharma *et al.*, 2021). Adjustments in timing and quantity of fertilizer N are likely to be necessary for optimum supply of N to wheat and maize crops, receiving residues. Keeping in view the above mentioned facts, the present study was planned.

MATERIALS AND METHODS

The study was carried out at Punjab Agricultural University, Ludhiana and University Seed Farm, Ladhowal, starting from 2016–2018, while the soil analysis and other lab work concluded in 2019. The soil was sandy loam at both the experimental fields. The physical and chemical properties at the start of experiment are listed in Table 1. The experimental field at Ladhowal was medium in organic carbon and available nitrogen. The available phosphorus and potassium in the soil were high. The values of electrical conductivity and soil pH lied in the normal range. While the experimental field at PAU was low in organic carbon and available nitrogen. However, available phosphorus and potassium status were medium. The values of electrical conductivity and soil pH lied in the normal range. The experiment was laid in split-split plot design with three replications, each having two main plots, four sub plots and three sub-sub plots. The main treatments were deep tillage at 45 cm depth (DT) and shallow tillage at 15 cm depth (ST). Deep tillage plots were tilled with sub-soiler at one meter spacing, while under shallow tillage treatment no sub-soiler was used. The sub treatments were the combinations of tillage and residue management i.e. Conventional tillage without residue (CT-R), Conventional tillage with residue (CT+R), Minimum tillage without residue (MT-R) and Minimum tillage with residue (MT+R). Conventional tillage was done with one operation of disc harrow and two operations of cultivator followed by planking. While under minimum tillage, the seed was directly placed without any ploughing. Maize residue was retained in wheat crop, while, wheat residue was retained in maize crop. The sub-sub treatments had three levels of N i.e. 75, 100 and 125% of recommended fertilizer-N.

The maize stover was cut into pieces with mechanical chaffer and spread out evenly in the plots (5 t ha^{-1}) in which residue was to be retained while all maize stover was removed from the plots in which residue was to be removed. After wheat harvest, all the loose residues were removed and only the anchored wheat stubbles were retained in the plots requiring residue retention treatments (1 t ha^{-1}). Diammonium phosphate was drilled at the time of sowing of wheat and maize in all experimental units @ 60 kg ha^{-1} P_2O_5. Nitrogen was applied as treatment in the form of urea at three different levels of 90, 120 and 150 kg ha^{-1}, divided into two and three equal doses in wheat and maize, respectively. Due to poor soil fertility, the dose of nitrogen was increased by 25% at location 1 (Ludhiana). The nitrogen fertilizer was applied in two equal doses in wheat- before first and second irrigations while in maize, three equal splits of N were applied at sowing, knee high stage and at pre-tasseling stage. Wheat variety PBW-677 and maize hybrid PMH-1 were used in the experiment. Wheat sowing was done during third week of November (both years, both locations) with happy seeder, by using 100 kg ha^{-1} seed, while maize sowing was completed during first week of June, with 20 kg seed ha^{-1} sown in 60 cm wide rows. Plant protection measures and irrigation were applied as and when required. Both crops were manually harvested, and then weighed for biological yield data.

The composite soil samples taken from each plot after

Table 1. Important soil properties of the experimental sites before the start of the experiment

Characters	Ludhiana		Ladhowal	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm
$pH_{1:2}$	7.4	7.4	8.3	8.5
Electrical conductivity (E.C.$_{1:2}$; dS m^{-1})	0.23	0.22	0.26	0.20
Soil organic carbon (g kg^{-1})	3.6	3.7	4.3	5.2
Available N (kg ha^{-1})	166	143	245	222
Available P (kg ha^{-1})	20.4	19.0	25.5	23.2
Available K (kg ha^{-1})	198	165	291	270

harvesting of maize crop at the end of experiment of the cropping cycle then were air dried, grinded and sieved. The soil organic carbon in the soil is determined by rapid titration method. The available nitrogen of the soil was determined by alkaline potassium permanganate method. Available phosphorus in the soil was determined using 0.5 M sodium bicarbonate method. Available K was estimated by ammonium acetate extraction method. To obtain BD (g cm^{-3}), the undisturbed soil cores were taken from 0-15 cm depth with the help of cylindrical core and dried in an oven at 105 °C till the weight of the soil becomes constant. Infiltration was measured, in-situ by double ring infiltrometer method. Water was filled in both the outer and inner rings and the fall of water levels in the inner ring was recorded at different time intervals till the water intake rate became constant. Penetration resistance (PR) was measured by a hand-held digital cone penetrometer (CP40II; Rimik electronics, RFM Australia) at two randomly selected locations within a plot. Soil PR readings were recorded up to 45 cm depth. The measurements were made at the end of the experiment. The microbial count or enumeration of bacteria, fungi and actinomycetes was done on nutrient agar medium, glucose yeast extract medium and kenknight's medium respectively, using serial 50 dilution spread plate technique while the soil dehydrogenase activity (DHA) was assayed with the method of Tabatabai (1982).

The data recorded for different parameters were analyzed with the help of analysis of variance (ANOVA) technique for split-split plot design using SAS 9.1 software (SAS Institute, Cary, NC). Mean values ($p<0.05$) were considered statistically significant using Tukey's *posthoc* test procedure where ANOVA was significant and results are presented at 5% level of significance.

RESULTS AND DISCUSSION

Soil physical properties

After two years of study, lower values of bulk density (BD) were recorded under deep tillage treatment as compared to shallow tillage both at Ludhiana and Ladhowal, the differences were however non-significant (Tables 2 and 3). The different combinations of tillage and residue retention did not significantly affect the bulk density, though conventional tillage with residue recorded lesser BD values than other tillage methods. Addition of organic matter through incorporation of crop residues could be the reason behind this. Different levels of N fertilization also did not have any significant effect on bulk density. Similar results were reported by Qingjie *et al.* (2014). The tillage treatment, various combinations of tillage and crop residue and various levels of N fertilization did not significantly influence the soil aggregation values, although higher values of soil aggregation were noticed under conventional tillage with residue treatment (CT+R) at both locations. This could be due to incorporation of crop residue and its even distribution in the soil, which acted as a source of organic matter and provided surface for binding of soil aggregates. The steady state infiltration rate (IR) was recorded at 300 minutes after applying irrigation and was not significantly affected by deep tillage, minimum or conventional tillage, with or without crop residue, and various levels of N fertilizer (Tables 2 and 3) at any of the two locations. However, at both locations higher values of IR were noticed under conventional tillage with residue, followed by minimum tillage, which may be attributed to lesser bulk density under the former treatment. IR under MT-R and MT+R treatments was more than CT-R. The higher IR in the plots under minimum tillage was probably due to minimum disturbance that maintained the continuity of water conducting pores and bio-channels.

The data regarding penetration resistance was recorded at three depth ranges of soil profile i.e. 0 to 15 cm, 15 to 30 cm and 30 to 45 cm. The data showed that penetration resistance was significantly influenced by deep tillage treatment in 15 to 30 cm and 30 to 45 cm depth at both locations. At Ludhiana, in 30-45 cm soil profile the deep tillage treatment recorded 2.23 MPa which was significantly lesser than the penetration resistance observed under shallow tillage treatment which was 2.34 MPa (Table 2 and 3). The trend was similar in the 15 to 30 cm soil depth. However, in the upper 0 to 15 cm soil layer this effect was non-significant. Lesser penetration resistance observed under deep tillage treatment may be because of reduction in soil compaction by deep tillage treatment. Ji *et al.* (2013) reported significantly lower penetration resistance at various soil depths under deep tillage treatment as compared to shallow tillage treatment. The combinations of tillage and crop residue also significantly affected the penetration resistance as lesser resistance was recorded under conventional tillage with residue as compared to other three tillage treatments at both locations and at all soil profile depths. This happened may be due to lower bulk density under CT+R treatment. Similar results stating lesser penetration resistance under CT as compared to MT were reported by Kirkegaard *et al.* (1994). Various levels of nitrogen fertilizer did not influence penetration resistance.

Soil chemical and biological properties

At both locations, deep tillage and the combinations of tillage and residue retention did not significantly affect the available N, P and K values (Tables 2 and 3). With respect to the different levels of N, it was observed that available P and K did not differ significantly, but available N varied significantly among each other at all the three levels, the highest being at 125% N (N_{125}). At Ludhiana, the N_{125}

Table 2. Effect of tillage, crop residue and nitrogen on bulk density, soil aggregation and steady state infiltration rate (IR) at Ludhiana

Treatments	Bulk density (g cm^{-3})	Soil aggregation (%)	Steady state IR (cm hr^{-1})	Penetration resistance (MPa) Soil profile (cm)			Nutrients (kg ha^{-1})			Microbial count (×10^{6} CFU g^{-1} soil)	Dehydrogenase activity (µg TPF g^{-1} of soil hr^{-1})	Soil organic carbon (%)
				0-15	15-30	30-45	N	P	K			
Tillage												
ST	1.43	64.6	2.5	1.17	2.90	2.34	167	19.9	198	73.0	2.84	0.38
DT	1.41	63.7	2.7	1.12	2.78	2.23	179	20.2	205	74.4	2.96	0.40
CD (P=0.05)	NS	NS	NS	NS	0.11	0.10	NS	NS	NS	NS	NS	NS
Tillage × crop residue												
CT-R	1.41	63.5	2.5	1.12	2.79	2.25	170	20.2	197	70.7	2.73	0.38
CT+R	1.41	65.0	2.7	1.08	2.68	2.16	178	20.5	207	74.4	2.99	0.40
MT-R	1.44	63.9	2.6	1.20	2.98	2.39	172	19.3	199	73.8	2.86	0.39
MT+R	1.42	64.2	2.7	1.17	2.90	2.33	174	20.3	202	75.8	3.01	0.40
CD (P=0.05)	NS	NS	NS	0.03	0.07	0.06	NS	NS	NS	3.0	0.11	NS
Nitrogen levels												
N_{75}	1.42	63.8	2.6	1.15	2.85	2.30	160	19.5	197	65.4	2.73	0.39
N_{100}	1.42	64.3	2.6	1.15	2.84	2.28	174	20.0	201	76.8	2.93	0.40
N_{125}	1.41	64.4	2.7	1.14	2.82	2.27	186	20.6	206	78.9	3.04	0.40
CD (P=0.05)	NS	NS	NS	NS	NS	NS	9	NS	NS	2.8	0.11	NS

Table 3. Effect of tillage, crop residue and nitrogen on bulk density, soil aggregation and steady state infiltration rate (IR) at Ladhowal

Treatments	Bulk density (g cm^{-3})	Soil aggregation (%)	Steady state IR (cm hr^{-1})	Penetration resistance (MPa) Soil profile (cm)			Nutrients (kg ha^{-1})			Microbial count (×10^{6} CFU g^{-1} soil)	Dehydrogenase activity (µg TPF g^{-1} of soil hr^{-1})	Soil organic carbon (%)
				0-15	15-30	30-45	N	P	K			
Tillage												
ST	1.51	71.2	1.8	1.74	3.49	3.00	245	25.3	289	80.5	3.14	0.44
DT	1.49	70.3	1.9	1.67	3.37	2.89	256	25.7	303	83.0	3.17	0.45
CD (P=0.05)	NS	NS	NS	NS	0.10	0.10	NS	NS	NS	NS	NS	NS
Tillage × crop residue												
CT-R	1.50	70.1	1.8	1.68	3.38	2.90	248	25.0	291	78.8	2.98	0.44
CT+R	1.49	71.6	1.9	1.61	3.25	2.79	256	26.1	303	83.7	3.26	0.46
MT-R	1.52	70.4	1.8	1.79	3.58	3.09	246	25.0	294	80.2	3.14	0.44
MT+R	1.50	71.0	1.8	1.74	3.51	3.01	251	25.9	297	84.4	3.24	0.45
CD (P=0.05)	NS	NS	NS	0.04	0.09	0.07	NS	NS	NS	3.4	0.15	NS
Nitrogen levels												
N_{75}	1.51	70.3	1.8	1.71	3.45	2.96	233	24.8	289	78.0	2.74	0.44
N_{100}	1.51	70.9	1.8	1.71	3.43	2.95	251	25.5	297	82.4	3.31	0.44
N_{125}	1.49	71.1	1.9	1.69	3.41	2.93	268	26.2	303	84.9	3.42	0.45
CD (P=0.05)	NS	NS	NS	NS	NS	NS	12	NS	NS	3.0	0.14	NS

treatment recorded 186 kg ha^{-1} available N in maize-wheat system, which was significantly higher than both N_{100} (174 kg ha^{-1}) and N_{75} treatments (160 kg ha^{-1}). At Ladhowal also, the N_{125} treatment (268 kg ha^{-1}) was significantly better in available N as compared to N_{100} (251 kg ha^{-1}) and N_{75} treatments (233 kg ha^{-1}). The addition of more amount of nitrogenous fertilizer could have increased mineralization of N, thus increasing available N. Wozniak and Gos (2014) reported higher values of available soil N under treatment of 150 kg ha^{-1} nitrogen as compared to 90 kg ha^{-1} nitrogen dose.

The soil organic carbon (SOC) values, as compared to the initial status of 0.36% at Ludhiana and 0.43% at Ladhowal under maize-wheat system improved in general to show final values of 0.39% at Ludhiana and 0.45% at Ladhowal at end of 2 year experimentation. These improvements in SOC values were more pronounced under minimum tillage as compared to conventional tillage, and in the plots with residue retention than without residue retention plots, although these improvements were statistically non-significant. The addition of organic matter in the form of crop residues in every *kharif* and *rabi* season during 2 years of study increased the SOC content in residue retained plots both under conventional and minimum tillage, as organic matter is the raw material for production of SOC. Further, higher number of micro-organisms and lesser soil disturbance, causing lesser oxidation of organic matter could be the reason for improvement in SOC status under minimum tillage plots. Higher status of SOC under no tillage or minimum tillage in comparison with conventional tillage has been reported by other research workers viz. Dikgwatlhe *et al.* (2014), Kurothe *et al.* (2014) and Saha and Ghosh (2013). Fertilizer N levels also did not significantly affect the SOC but in general increase in SOC content was noted as the N levels increased from 75% towards 125%. Higher crop biomass available as a source of organic matter and higher microorganism populations under higher N levels may be the reason behind this trend. Sharma *et al.* (2011) have reported similar findings.

Deep tillage did not influence soil microbial population significantly while significant difference in microbial count was noted among different combinations of tillage and crop residue retention and also among different N fertilizer levels. At both locations, the MT+R treatment recorded highest microbial population, which was statistically at par with CT+R, but significantly higher than CT-R and non-significantly higher than MT-R. Crop residue either retained as mulch or incorporated with tillage increased the soil microorganism populations. This may happen because of the crop residue acted as a source of food and a substrate to grow for microbial populations. Minimum tillage with and without residue had higher microbial population than conventional tillage without residue. Lesser soil disturbance under minimum tillage may have provided a stable habitat to microorganisms (Jatta *et al.*, 2015). The application of mulch helps in retaining soil moisture during hot summer months, which creates favourable environment for the microbial populations, which may justify higher microbial populations under MT as compared to CT systems (Sun *et al.*, 2016) and with application of organic mulch in addition to inorganic fertilizer. The conventional tillage with crop residue recorded more microbial count than minimum tillage without crop residue. This may be due to the fact that under conventional tillage with residue treatment, the residue was incorporated into the soil and was evenly distributed into the soil profile, making more soil contact, and better exposure for microbial breakdown and decomposition, hence increasing the substrate availability for microorganisms. The microorganism populations increased with increasing N levels. The N_{125} and N_{100} levels, which were at par among themselves, had significantly higher count of microbial colonies as compared to N_{75} treatment at both locations. This may be due to better growth environment and decomposition conditions created by improvement in C : N with addition of more nitrogen. Chu *et al.* (2007) concluded from their long term study that soil microbial biomass C and dehydrogenase activity were significantly better under balanced fertilization as compared to deficient fertilization.

Soil enzymatic activity

Dehydrogenase enzyme plays a role in oxidation of substrates (organic matter) and is a reliable indicator of microbial activity in soil. The dehydrogenase activity (DHA) is influenced by any disturbance caused to the soil through pollutants or any management practices. While deep tillage (Table 2 and 3) had no significant effect on enzyme activity, the maximum DHA value was recorded under minimum tillage with crop residue. It was at par with conventional tillage with residue but significantly higher than minimum tillage without residue and conventional tillage without residue. Majchrzak *et al.* (2016) found a significant increase in dehydrogenase enzyme activity (DHA) under no tillage as compared to conventional tillage in spring wheat soils. Higher DHA values were observed under higher nitrogen levels. The N_{125} treatment recorded 3.04 µg DHA, which was at par with N_{100} level (2.93 µg) but significantly higher as compared to N_{75} treatment (2.73 µg) at Ludhiana. The other location also had similar trend. This might be due to higher microbial count under higher levels of nitrogen ous fertilizer.

Grain yield

The deep tillage had no significant effect on grain yield of maize at Ludhiana but on heavy soils of Ladhowal, the maize grain yield was significantly higher under deep tillage treatment, amounting to 12% and 8% increase in 2017 & 2018 resp. (Table 4). This might be due to the reason that at Ladhowal the soil is heavy textured and was under rice-wheat rotation for the past few years which might have increased compaction. Deep tillage done with chiseler might have been helpful in reducing compaction, thus favouring root expansion. While at Ludhiana the soils are light textured with more sand content and compaction may not be prominent. This is evident from the data of penetration resistance (Tables 2 and 3). Ji *et al.* (2013) reported 4.9 to 6.5% increase in grain yield of maize with deep tillage treatment in comparison with shallow tillage treatment. However in wheat crop (Table 4), the grain yield was not affected by the deep tillage treatment, which may be due to shallow rooting system in this crop.

In both crops (maize and wheat), the grain yield was not significantly affected by tillage and crop residue combinations while the different levels of nitrogen fertilizer significantly affected the grain yield of both crops, where N_{125} and N_{100} recorded significantly higher grain yield than N_{75} levels.

Thus, it may be concluded that in maize-wheat system, the four tillage and residue combinations under this study (CT-R, CT+R, MT-R and MT+R) did not significantly influence the grain yield in maize and wheat crops. The treatment where 125% of recommended N was applied (N_{125}), recorded significantly higher yield both in maize and wheat crops as compared to N_{75} treatment, but was statistically at par with N_{100} treatment. Deep tillage significantly increased the grain yield in maize as compared to the shallow tillage treatment at Ladhowal (which recorded higher penetration resistance as compared to Ludhiana).

The soil penetration resistance was significantly lower under deep tillage treatment as compared to shallow tillage treatment at both the locations. Conventional tillage with residue treatment recorded lowest penetration resistance as compared to other tillage and residue combinations. The soil properties like OC, available NPK, soil aggregation, infiltration rate improved under CT+R treatment of both the cropping systems but the effects were non-significant. A longer duration study may help to quantify these changes. The addition of crop residue both under minimum tillage and conventional tillage significantly increased the soil microorganism count and dehydrogenase enzyme activity. CT-R treatment recorded lowest microorganism count and dehydrogenase enzyme activity. The available soil nitrogen, microorganism count and dehydrogenase enzyme activity significantly increased with increasing nitrogen doses at both locations and were highest under 125% N level as compared to 75% and 100% levels.

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Table 4. Effect of tillage, crop residue and nitrogen on grain yield of maize and wheat

Treatments	Grain yield (q/ha)							
	Maize				Wheat			
	Ludhiana		Ladhowal		Ludhiana		Ladhowal	
	2017	2018	2017	2018	2017	2018	2017	2018
Tillage								
ST	50.6	48.7	52.1	50.0	47.2	49.4	51.3	54.1
DT	54.5	51.5	58.3	54.0	48.4	50.9	52.5	55.3
CD (P=0.05)	NS	NS	5.2	3.8	NS	NS	NS	NS
Tillage × crop residue								
CT-R	53.3	50.7	56.6	53.3	49.4	51.7	53.4	56.5
CT+R	51.9	49.6	54.1	51.5	46.3	49.3	50.4	53.1
MT-R	52.2	49.7	54.8	51.2	47.5	49.5	51.6	54.3
MT+R	52.8	50.2	55.3	51.8	48.0	50.0	52.2	54.8
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen levels								
N_{75}	49.3	47.3	49.0	48.1	44.7	46.5	48.8	50.4
N_{100}	53.3	50.8	57.4	53.4	48.4	51.1	52.5	56.3
N_{125}	55.1	52.2	59.1	54.4	50.4	52.8	54.4	57.3
CD (P=0.05)	2.1	1.6	2.0	1.5	2.1	2.0	2.1	2.4

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