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Effect Of S And N Fertilization On Yield Of Wheat Grain

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ABSTRACT

The research set out to assess the impact of N and S fertilizer on spring wheat production and quality from a technical standpoint. In 2015–2017, researchers in India carried out a field study. Fertilization using sulphur (S) as well as nitrogen (N) was tested. The addition of S considerably raised the concentration of gluten (3.2%), cysteine (6.0%), and methionine (16.5%). The levels of nitrogen, sulfur, total protein, gluten, cysteine, and methionine were all positively affected by nitrogen applications of 80 kg/ha and sulfur applications of 50 kg/ha. The amount of S in grain was shown to positively correlate with harvest success (r = 0.73). Grain yield was also shown to have significant correlations with all quality variables except nitrogen and starch content.

KEYWORDS grains per ear, 1000-grain weight, sulphur and nitrogen, Wheat Gain.

INTRODUCTION

As two of the most fundamental building blocks of protein, N and S should both be present in sufficient quantities for maximum crop output. Intake and absorption of NO3 and SO4 2- are quite similar, and numerous metabolic products of N and S interact with one another. Plants lacking sulfate tend to store more of the amino acids arginine and asparagine, whereas cysteine and methionine are reduced. When asparagine builds up in wheat grains due to a lack of vitamin S, acrylamide may occur in baked goods made from the flour. O-acetylserine, the immediate precursor of cysteine that does not include S, contributes to the interplay between N and S metabolism. As an amino acid, sulfate absorption in plants requires a sufficient supply of this precursor, and this in turn is reliant on N nutrition. Gluten's S-rich subunits, gliadins and glutenins, produce interchain disulphide linkages that contribute to the dough's flexibility. When there is a scarcity of sulfur relative to nitrogen, the proportion of S-rich proteins like -gliadins and glutenin subunits with a low molecular weight rises, while the proportion of S-poor proteins like -gliadins and -gliadins falls.

There are three factors that contribute to cereal grain yield: the yield per area, the amount of grains harvested from each ear, and the weight of a single grain. Since the number of ears is the first aspect of yield to stabilize throughout development, it is of paramount significance. A low yield cannot be made up for by increasing the quantity of grains per ear or the weight of the grains, although they may help. Thus, there is a common positive relationship between ear count and harvest success. Sometimes, when one factor is altered, the others will adjust to maintain a constant grain production.

LITERATURE REVIEW

Marzena Mikos-Szymańska et.al (2018) This study aimed to determine how various fertilizer treatments will influence the total grain yield and its constituent parts in the spring wheat 'Harenda' cultivar. The control group received standard NPK fertilization, the second group received liquid NPK fertilizer, the third group received microelement-enriched liquid NPK fertilizer, the fourth group received calcium micronized suspension fertilizer, and the fifth group received standard NPK fertilization. Foliar treatments of calcium micronized suspension nutrition and a combination of copper, manganese, zinc, and calcium micronized suspension nutrient significantly increased spring wheat grain output by 44.5% and 38.6%, respectively. All locations where spring wheat was planted had increased yields after receiving fertilization.

Fresew Belete et.al (2018) Increasing production in the research region has traditionally included applying huge quantities of nitrogen fertilizer, which is both expensive and may lead to environmental degradation. The nitrogen content of grains was significantly influenced by the interactions between growing season, nitrogen application rate, and cultivar. Nitrogen content in both grain and straw responded to when, how much, and what sort of nitrogen fertilizer was applied throughout the growing season. Tsehay yields in 2015 were statistically equal to those generated by the Menze variety when fertilized at rates of 240 and 360 kg N ha1, and to those produced by the Tsehay variety when fertilized at rates of 240 and 360 kg N ha1. The maximum total nitrogen content was found in grain and straw from the Tsehay variety, which was cultivated at a N rate of 360 kg ha1. Variety Tsehay, when fertilized with 120 kg N ha1 in both seasons, had the best apparent nitrogen recovery efficiency. The majority of the nitrogen use efficiency measures did not significantly differ across the wheat types studied during either growing season, and they deteriorated when the N rate was increased over 120 kg ha1.

DINESH PRATAP SINGH et.al (2017) Wheat yields rose by as much as 120 kg N ha-1 and as much as 7.5 t FYM ha-1 compared to their respective controls, according to data collected over a two-year period. The findings demonstrated that boosting wheat productivity with both FYM and nitrogen fertilizer was more effective than improving wheat productivity with only nitrogen fertilizer. With 7.5 t FYM ha-1, wheat grain and straw yields increased by 24.2% and 23.4%, respectively, compared to the control. Protein concentration and yield both benefited from N applications of up to 120 kg N ha-1. Wheat grain protein content and yield were shown to be considerably increased when 7.5 t FYM ha-1 was applied, compared to the control. Wheat plants were shown to absorb more nitrogen, phosphorus, potassium, sulfur, and copper than controls. Furthermore, compared to no FYM application, nutrient absorption was dramatically enhanced when FYM was used.

P. RUSEK et.al (2016) The research set out to compare the efficiency of conventional fertilizer to that of urea superphosphate (USP) on the yield and quality of winter wheat. In comparison to the conventional fertilizers evaluated, the USP fertilizer demonstrated similar levels of nitrogen and phosphorus assimilability in plant growth. When compared to wheat yields from non-treated plots, average yields from plots fertilized with USP and CSP with urea were around 30% higher. Wheat quality was improved as a result of nitrogen-phosphorus fertilization, which raised the grain's nitrogen, protein, and gluten levels. The USP fertilizer product tested well in terms of its fertilizing effects.

METHODS

Using a randomized split-plot design, a field experiment was performed in Malice, southeast Poland, between 2015 and 2017 on Cambisols consisting of light silty sand. Soil pH was on the acidic side (5.6), and its accessible phosphorus (P) level was high, while its potassium (K) and magnesium (Mg) contents were moderate, and its sulfate (S) content was low (Table 1).

The spring wheat (Triticum aestivum L.) cv. Tybalt was subjected to 8 various fertilization regimes. Table 2 presents a plan for the timing and dosage of N and S applications. Each plot was 5 by 6 meters in size, for a total of 30 square meters. Fertilizers were administered before to planting, namely phosphorus and potassium. Ammonium nitrate (NH 4NO3), at a concentration of 34%, was used to provide the crop with nitrogen. Using Mg lime and Ca carbonate, we were able to achieve a pH and Mg balance in the plot soil by applying kieserite and magnesium sulphate heptahydrate.

The spring wheat was planted at a rate of 500 plants per square meter. The dates for planting varied from year to year, falling anywhere from March 28 to April 5. Herbicides include Granstar 75

Table 1. Chemical characteristics of soil

Description	Method	Unit	2015	2016	2017
pH in 0.01 mol/L $CaCl_2$	potentiometrically using a Methrohm 605 pH-meter	–	5.6	5.7	5.8
C_{tot}	combustion by LECO EC-12®, model 752-100	g/kg	9.2	8.9	7.7
N_{tot}	by the Kjeldahl's method		0.9	0.9	0.7
N_{min}	content N-NO_3 + N-NH_4 × 1.38 (soil bulk density, mg/m³) (PN-R-04038, 1997)	kg/ha	72.8	68.4	64.9
P_{avail}	extracted by double lactate and determined by colorometric method – Egner Riehm DL method (PN-R-04023, 1996)		54.5	53.5	48.3
K_{avail}	extracted: see phosphorus. Determined by the photometric method. (PN-R-04022, 1996)		88.6	85.2	79.6
Mg_{avail}	extracted by 0.0125 m/L $CaCl_2$ and determined by AAS. (PN-R-04020, 1994)	mg/kg	34.8	33.7	35.1
S_{tot}	by ICP-AES, mineralization with HNO_3 + $Mg(NO_3)_2$		102.8	86.3	72.0
S-SO_4	extracted by 0.025 mol/L KCl and determined by ion-chromatograph		14.2	12.6	10.3

Each plot's grain yield was calculated after harvest. The LECO CNS-2000 analyzer was used to determine the total N and P content of the grain. Both the S and N contents were measured using infrared spectroscopy and a differential thermal conductivity detector, respectively. S-containing amino acids cysteine and methionine were analyzed in an HPLC-based INGOS AAA 400 amino acid analyzer. Perten Instruments Inframatic 9200 grain analyzer near-infrared spectroscopy was utilized to quantify gluten and starch content. The grain's protein content was determined to be 5.7 N.

Table 2. Schema for rates of nitrogen and sulphur

Element	Rate (kg/ha)	Time of application		
		before sowing	30–31 BBCH	55–59 BBCH
Nitrogen	0	–	–	–
	40	40	–	–
	80	40	40	–
	120	40	40	40
Sulphur	50	40	–	10

DATA ANALYSIS

The results showed that N and S fertilizer significantly boosted spring wheat's production and improved the majority of its quality characteristics. There was no relationship between increasing N and S treatment rates and grain production or the features we investigated. Yield and other characteristics were separately improved by adding sulphur to each nitrogen application. The presence of a yield-boosting ingredient, in this instance fertilizer, is indicative of S's additive impact. This kind of reaction is typical in situations when there is just a little deficiency of food, as predicted by the law of diminishing returns. When there is a steady gain in weight with the addition of a second component, the additive interaction of the nutrients is most apparent.

In both the case of 80 kg N/ha (5.40 t/ha) and 120 kg N/ha (albeit not statistically significant), grain yield was best after application, rising by 1.30 t/ha (13.1%) relative to the control. As the N application rate rose, so did the weight per thousand grains. Increases in both nitrogen and sulphur content of spring wheat grain were shown to be directly proportional to

Table 3. Yield of grain of spring wheat, thousand-grain weight and nitrogen and sulphur content

Fertilization		Grain yield (t/ha)	Mass of 1000 grains (g)	Nitrogen (g/kg DM)	Sulphur (g/kg DM)	N:S ratio
Sulphur (S)	nitrogen (N)					
0S(N×S)	0	4.03^{a}	33.78^{a}	25.40^{a}	1.24^{a}	20.51^{a}
	40	5.15^{a}	34.46^{a}	26.88^{a}	1.24^{a}	21.70^{a}
	80	5.36^{a}	35.40^{a}	27.69^{a}	1.33^{a}	20.86^{a}
	120	5.47^{a}	37.43^{a}	28.40^{a}	1.37^{a}	20.88^{a}
50S (N × S)	0	4.13^{a}	34.36^{a}	25.61^{a}	1.25^{a}	20.50^{a}
	40	4.38^{a}	34.82^{a}	27.58^{a}	1.28^{a}	21.73^{a}
	80	5.43^{a}	35.53^{a}	27.81^{a}	1.34^{a}	20.79^{a}
	120	4.72^{a}	36.31^{a}	28.78^{a}	1.40^{a}	20.70^{a}
Mean (S)	0	4.75^{B}	35.27^{A}	37.09^{B}	1.30^{B}	20.99^{A}
	50	4.92^{A}	35.26^{A}	37.44^{A}	1.32^{A}	20.93^{A}
Mean (N)	0	4.08^{B}	34.07^{AB}	25.50^{C}	1.25^{C}	20.50^{B}
	40	4.27^{AB}	34.64^{AB}	27.23^{B}	1.26^{C}	21.72^{A}
	80	5.40^{A}	35.46^{A}	27.75^{B}	1.34^{B}	20.83^{B}
	120	5.59^{A}	36.87^{A}	28.59^{A}	1.39^{A}	20.79^{B}
Mean	2015	4.74^{B}	38.15^{A}	28.52^{A}	1.25^{C}	22.83^{A}
	2016	4.68^{B}	31.38^{C}	27.94^{B}	1.29^{B}	21.64^{B}
	2017	5.09^{A}	36.25^{B}	25.34^{C}	1.38^{A}	18.40^{C}

nitrogen (N) and sulfur (S) per kilogram of dry matter (DM) were both greatest after 120 kg N/ha was applied. The N:S ratio remained stable between the control and 80 kg N/ha and 120 kg N/ha (Table 3), although it rose from an average of 20.71 to 21.72 at 40 kg N/ha.

Specifically, 120 kg N/ha resulted in the greatest gluten concentration (34.15%), which correlated positively with the N application rate. Total protein content also responded well, with the highest increases seen after applying 80 and 120 kg of nitrogen per hectare, respectively (15.73% and 16.28%, respectively).

There is a lot of discussion in the scientific literature on how N fertilization affects the yield and technical value of high-quality wheat (Pilbeam, 2015). Fertilization with a variety of minerals, including S, is given a lot less attention. Reduced grain S levels compared to Critical levels for S insufficiency in terms of yield seem to be 2 mg/g and a grain N:S ratio more than 17:1.

Table 3 shows that there was no change when looking at the influence on a 1000-grain weight. Winter wheat plants with low levels of S-SO4 in the soil produced lower yields, according to research, whereas plants fertilized with 60 kg S/ha of S increased grain production by 11%.

Table 4. The quality characteristic of grain of spring wheat

Fertilization		Starch	Gluten	Total protein	Cystine	Methionine
Sulphur (S)	nitrogen (N)		(%)			(mg/g)
0S(N×S)	0	62.2^{a}	25.23^{a}	14.47^{a}	3.65^{a}	2.70^{a}
	40	62.2^{a}	27.03^{a}	15.30^{a}	4.16^{a}	2.78^{a}
	80	62.2^{a}	29.70^{a}	15.80^{a}	4.33^{a}	3.00^{a}
	120	62.4^{a}	34.63^{a}	16.17^{a}	4.43^{a}	3.13^{a}
50S (N × S)	0	62.5^{a}	26.93^{a}	14.60^{a}	4.21^{a}	3.16^{a}
	40	62.6^{a}	28.70^{a}	15.70^{a}	4.29^{a}	3.32^{a}
	80	62.4^{a}	31.03^{a}	15.87^{a}	4.40^{a}	3.44^{a}
	120	62.4^{a}	33.67^{a}	16.40^{a}	4.64^{a}	3.60^{a}
Mean (S)	0	62.3^{A}	29.15^{B}	15.43^{A}	4.14^{B}	2.90^{B}
	50	62.5^{A}	30.08^{A}	15.64^{A}	4.39^{A}	3.38^{A}
Mean (N)	0	62.3^{A}	26.08^{C}	14.53^{D}	3.93^{C}	2.93^{BC}
	40	62.4^{A}	27.87^{B}	15.50^{C}	4.23^{AB}	3.05^{B}
	80	62.3^{A}	30.37^{A}	15.83^{B}	4.37^{A}	3.22^{A}
	120	62.4^{A}	34.15^{A}	16.28^{A}	4.53^{A}	3.37^{A}
Mean	2015	62.1^{AB}	28.52^{B}	16.25^{A}	4.37^{A}	3.17^{A}
	2016	62.3^{B}	30.14^{A}	15.91^{B}	4.37^{A}	3.12^{A}
	2017	62.6^{A}	30.19^{A}	14.45^{C}	4.05^{B}	3.13^{A}

Today's standard of grain quality S fertilizer treatment enhanced the research. Although there was a good reaction across the board, S treatment had no effect on starch or total protein levels. S applied after NPK fertilizer resulted in a 3.2% rise in gluten content, a 6.0% increase in cysteine, and a 16.5% increase in methionine (Table 5).

Table 5. Correlation coefficients between grain yield and grain quality characteristics

Features (*n* = 24)	**No**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Grain yield	1	0.328	0.331	**0.730**	–0.257	0.007	**0.813**	**0.449**	**0.478**	**0.497**
1000-grain weight	2	–	0.152	0.128	0.017	–0.035	0.096	0.039	0.100	0.068
Nitrogen	3	–	–	–0.085	**0.727**	–0.315	**0.414**	**1.000**	**0.767**	0.359
Sulphur	4	–	–	–	**–0.707**	0.379	**0.764**	0.123	0.211	0.371
N:S ratio	5	–	–	–	–	**–0.463**	–0.205	**0.763**	0.401	–0.005
Starch	6	–	–	–	–	–	0.106	–0.341	–0.085	0.402
Gluten	7	–	–	–	–	–	–	**0.414**	**0.589**	**0.428**
Total protein	8	–	–	–	–	–	–	–	**0.766**	0.358
Cysteine	9	–	–	–	–	–	–	–	–	**0.609**
Methionine	10	–	–	–	–	–	–	–	–	–

It's important to note that the benefits of the higher N levels achieved after 120 kg N/ha were smaller than those achieved after 80 kg N/ha was applied in comparison to 40 kg N/ha. The principle of decreasing returns (or Mitscherlich's law) provides an explanation for this observation.

CONCLUSION

Grain yield in this research of spring wheat was shown to be correlated with the amount of sulphur contained in the grain. This suggests that the S content was optimized throughout the vegetative period of the plants and was not affected by the dilution effect. Due to the high degree of N avail-ability in mineral form in the soil investigated and the predicted supply from the environment, the recommended N application rate may be sufficient to meet the nitrogen requirements of spring wheat.

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