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The Effect of Fertilizers on Wheat Mutant Varieties

Bayarsaikhan B (Ph.D), Tuul D (Ph.D), MyagmarsurenYa(Ph.D), DolgorTs

Institute of Plant and Agricultural Sciences, Darkhan, Mongolia

***Corresponding Author:** Bayarsaikhan B (Ph.D), Institute of Plant and Agricultural Sciences, Darkhan, Mongolia*

ABSTRACT

Application of fertilizers in wheat production system is an important issue in order to achieve maximum profitable production, and minimum negative environmental impact in Mongolian condition. The aim of this investigation carried out in Institute of Plant and Agricultural Sciences (IPAS), was to estimate the effect of fertilizers on yield and protein content of 2 different mutant wheat varieties (Darkhan-34, Darkhan-141, Darkhan-172). Studied 5 fertilizer treatments: 0, N_{20}, $N_{20}P_{20}$ and $N_{20}P_{20}K_{18}$,Gumatfor both mutant wheat varieties. Fertilizers were applied to soil during the seeding time of wheat mutant varieties.

The result showed that the Darkhan-172 wheat mutant variety had higher grain yield (2.68 t/ha) and protein content (13.5%) than Darkhan-141 variety. But Darkhan141 had more response to fertilizers than Darkhan-172. The highly significant effect on grain yield for both varieties had combined ($N_{20}P_{20}K_{18}$) fertilizer application. Also, the high protein content achieved in the this treatment for both varieties.

Keywords: *plant, production, protein, yield, cultivated area, land*

INTRODUCTION

Wheat is the most important crop and occupying over 90 percent of the total cropped area. Wheat is always harvested for human consumption, but may also be harvested as fodder and residuals of wheat for feed animals. In the frame of the IAEA's breeding project we have mutant wheat materials with wide genetic diversity and variability.

Mongolian crop growing area is concentrated in the central-northern part of the country, which contains about 67% of all cultivated land. Wheat comprises 75% of the cropping area and 73% of total crop production area.

The total cultivable area in Mongolia is estimated 1.7 million ha, which is about 1.1 % of the total area. Historically, gains in agricultural production of Mongolia have come through expansion of area cultivated. Cultivated land for crop has extended and raised from 122.000 (150.0) in 2007 to 355.000 in 2016. The land productivity is very low, on average of 1.0 t/ha (0.8-1.4t/ha).

According to research result, more than 70% of Mongolian cropland is light kastanozem soil. This type of soil always contains poor organic matter and has a low provision level of nutrients, especially of nitrogen. On the other hand we have not been using enough fertilizer for cropping system. The calculation of the nutrient balance shows negative values for NPK. The average deficit is approximately 70 % for N, 50% for phosphorus and 87% for potassium. There were replaced 12.5-50.0% of nutrients with fertilizers. It shows that the nutrients, which are lost due to crop harvest always is not enough replaced by the use of any fertilizers. Therefore, fertilization and irrigation of the wheat in arid and semi-arid regions are necessary for increasing the crop productivity.

Fertilizer application is an important management practice to improve soil fertility and crop yield in the kastanozem soil regions of Mongolia.

Especially, appropriate nitrogen practices have a good effect on both yield and grain protein.

Main objective of the field experiment that was conducted in 2013-2017, to find out the appropriate fertilization at planting application for wheat mutant varieties.

The goals were:

a) To find out the effects of nitrogen fertilizer on wheat varieties yield;

b) To ascertain the effect of nitrogen application on the protein contents of the tested varieties in the field.

MATERIALS AND METHODS

The experiment was conducted at the field of Institute of Plant and Agricultural Sciences in Darkhan-Uul province which situated in the central-northern part of Mongolia.

A study was conducted in 2013-2017, with a aim to determine the effect of fertilizer applied at the sowing time, on grain yield and seed quality to wheat mutant varieties Three varieties (standard Darkhan 34, mutant Darkhan 141, Darkhan 172) were treated with five different fertilizers (0-0-0, 20-0-0, 30-20-0, 30-20-20 NPK kg/ha and Gumat-120 kg/ha).

Also in 2016, the mutant variety Darkhan 141 was treated with four levels (0, 20, 40, 60 kg N/ha) of ^{15}N labelled fertilizer to found out an appropriate rate of N fertilizer at the sowing time and to assess the nitrogen use efficiency of wheat. For all experiments, a factorial approach in randomized complete block design with 4 replications was used. Totally 334 soil samples analysed for soil physic-chemical properties according the standard procedure and collected the data: grain yield (GIY), straw yield (STY), crude protein content (CP), starch content (STA) of wheat mutant varieties.

Wheat planting was done in the optimal time (15 May). The growing density was 400 seeds in square meter. Plot size was 2 m^2 (2.0m X 1.0m). The experimental design was completely randomized plots with three replications.

Experiment treatments are:

1. Control (without fertilizer)
2. N_{20}
3. $N_{20}P_{20}$
4. $N_{20}P_{20}K_{18}$
5. Gumat

All treatments were applied to the soil at the time of sowing. The crop received four irrigation in all. The crops were irrigated first at the time of germination a second irrigation at tillering stage, a third irrigation at stem elongation stage, a fourth irrigation at the time of spike emergency stage. The amount of each irrigation was 400 m^3/ha. For the experiment the ammonium nitrate (N-34%), super phosphate (P_2O_5-46%) and potassium chloride (K_2O-60%) were used as source of nitrogen, phosphorus and potassium, respectively. All other agronomic practices were kept uniform for all treatments.

Parameters observed during the course study were:

1. Before planting soil samples were taken from 0-20 depth they were analyzed for soil nutrients.
2. Emergency count. In the 14 days after planting 2 rows were selected at random from each plot at 3 places, their emergency were counted and means were taken.
3. Biological yield (t/ha) and grain yield (t/ha)
4. Grain protein content (%)
5. Data recorded were analyzed using ANOVA technique

Grain protein contents were determined by Kjeldali method. Humus content in soil was determined by Turing, nitrate nitrogen by using disulphafenol, available potassium and phosphorus were extracted by 1% carbohydrate ammonium and by using spectrophotometer and flame photometer, the pH (1:5 soil : water) extract was determined using a pH meter.

At physiological maturity the plant samples were taken from 1m2 of all plots and tied into bundles. Biological yields was recorded by weighing the bundles of each plot. The bundles were separated into seed and straw. The grain weight was recorded in kg and then subsequently converted into t/ha.

RESULTS

Agrochemical Soil Characteristics

Before planting the soil samples were taken from 0-20 and 20-40 depths and they were analyzed for some soil nutrients. Soil agrochemical properties of the soil at the experimental site are given in Table 1. The soil of experimental site has a low provision level of nitrogen and phosphorus for cereal crops and medium in potassium. The experimental site located in the semi-arid region of the country where organic matter level is low (humus content 1.15 %) (Table 1).

Table1. *Agrochemical characteristics of the soil at the experimental site (2013)*

Soil Type	Soil Depth	% Humus	Available nutrients			pH (H_2O)
			NO_3-N mg/kg	P_2O_5 mg/100g	K_2O mg/100g	
Chestnut Soil (Light clay)	0-20	0.96	2.8	1.1	11.5	7.17
	20-40	1.35	1.3	1.1	6.2	7.06

Analysis of soil samples from planting depth (0-20 cm) indicated low level of available nitrogen and phosphorus, medium in potassium, indicating that the nutrient may be a limiting factor for wheat production in the area. The upper 20 cm (arable layer) contains low (0.96%) organic matter (C), increasing to 1.35% in the subsoil (soil layer 20-40 cm). During the growth stage of wheat the soil nutrients in different treatments had different trend over time. We observed that the application of fertilizers influenced positively to the soil fertility.

Effect of Fertilizers on Yield of Wheat Mutant Varieties

The use of fertilizers at sowing time, are effective on improvement of seed germination and seedling growth of wheat mutant varieties, especially for Darkhan 141. Field germination of selected varieties increased from 6.3 % to 14.3% under fertilization.

These results showed that interactive effect of varieties and fertilizers had significant effect ($P<0.05$). The highest increased grain yield was recorded in NPK treatment. Application of N-P-K at the rate of 30-20-20 kg ha-1 to Darkhan 141 had maximum increased (1.22 t ha-1 or 83.6% compare to control) grain yield.

Table2. *Effect of fertilizers on yield of wheat mutant varieties, 2013-2017*

Treatments	Dakhan 34			Darkhan 141			Darkhan 172		
	Yield								
	t ha^{-1}	Increased from fertilizer		t/ha	Increased from fertilizer		t/ha	Increased from fertilizer	
		t ha^{-1}	%		t ha^{-1}	%		t ha^{-1}	%
Control	1.15	-	-	1.46	-	-	2.03	-	-
N	1.05	-	-	1.64	0.18	12.3	2.30	0.27	13.3
NP	1.27	0.12	10.4	2.16	0.70	47.9	2.90	0.87	42.8
NPK	-	-	-	2.68	1.22	83.6	2.91	0.88	43.3
Gumat	1.44	0.29	25.2	1.62	0.16	11.0	1.98	-	-
Mean	**1.23**	**0.21**	**17.8**	**1.91**	**0.56**	**38.7**	**2.42**	**0.67**	**33.1**

The lowest grain yield (on an average 1.23 t ha-1) was recorded in Darkhan 34 standart variety.

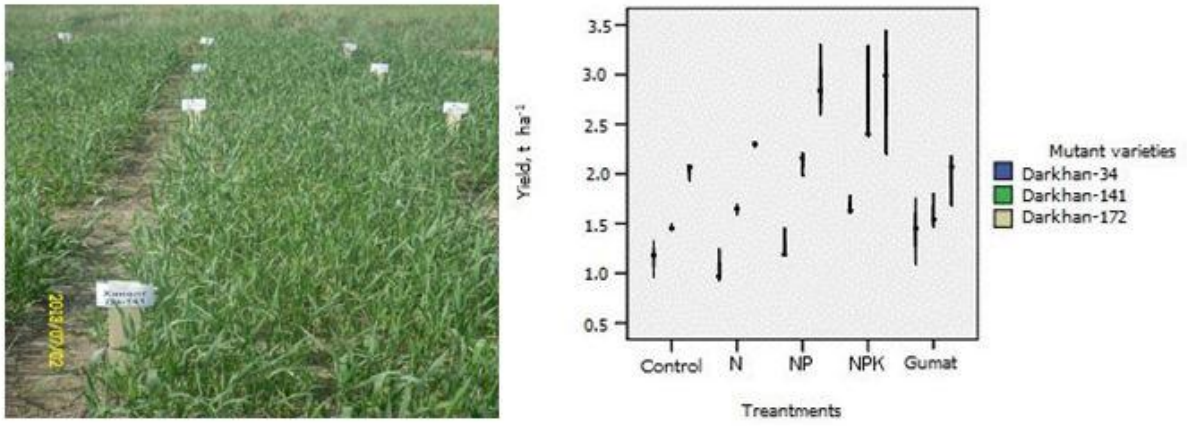

Photo1. *View of the field experimentPhoto 2. Effect of fertilizers on yield of wheat mutant varieties, 2013-2017*

The fertilization effected positively on grain protein content and increased 0.4-2.79%. The highest percentage of grain protein (16.3%) and gluten content (36.9) were obtained from combined nitrogen and phosphorus (NP) fertilizer.

Table3. *Effect of fertilizers on grain seed quality of wheat mutant varieties, 2013-2017*

Treatments	Darkhan 34	Darkhan141	Darkhan 172
Protein, %			
Control	12.5	11.9	13.0
N	14.1	12.6	13.2
NP	16.3	13.0	12.9
NPK	-	14.2	13.5
Gumat	11.9	11.5	-
Average	13.7	12.6	13.2
Gluten, %			
Control	29.2	29.5	29.6
N	30.9	30.8	34.0
NP	36.9	34.4	30.1
NPK	-	31.4	32.8
Gumat	23.8	24.6	-
Average	30.2	30.1	31.6

The total above ground biomass and its nitrogen content of the wheat mutant varieties were observed at the heading growth stage in 2014-2015. In the experiment treatment the biological yield of varieties in an average ranged from 5.8 to 16.0 t ha^{-1}. Use of biological (Gumat) fertilizer enhanced the vegetative growth of all varieties (except Darkhan 106), which ultimately increased biological yield with increase in straw yield. Higher biological yield (16.0 and 11.4 t/ha) was obtained with AL 547 variety by Gumat. (Table 3). Usage of single nitrogen (20 kg N ha^{-1}) fertilizer increased the biological yield from 0.1 to 1.9 %, compared to control in Al 547, Darkhan106, Al 561 varieties.

The results obtained in this study indicated that usage of N fertilization had positive effect on nitrogen content in biomass production. From the application of single nitrogen (20 kg N ha^{-1}) and nitrogen with phosphorus (30-20-0 kg NP ha^{-1}) increased nitrogen content in biomass of all wheat mutant varieties. The highest increased nitrogen content from those treatments obtained with Darkhan 141 and AL 561 varieties by in an average by 0.43%, compared to control.

Table4. *Effect of fertilization on biomass and its nitrogen content of wheat mutant varieties, 2014-2015*

Varieties	Fertilizer treatment							
	Control		N_{20}		$N_{30}P_{20}$		Gumat	
	Biomass (t/ha)	N (%)	Biomass (t/ha)	N (%)	Biomass (t/ha)	N (%)	Biomass (t/ha)	N (%)
Darkhan 34	11.9	1.54	10.3	1.77	5.80	2.03	12.2	1.35
Darkhan 141	11.2	1.44	11.0	1.76	6.70	2.10	14.4	1.41
Al 547	8.7	1.61	10.6	1.81	6.70	1.99	16.0	1.55
Darkhan 106	11.4	1.53	12.4	1.70	4.60	2.04	16.5	1.51
AL 561	11.1	1.57	11.2	1.85	6.60	2.34	15.8	1.64

The nitrogen use efficiency (NUE) was influenced by N rate. The result indicated that, the highest value of nitrogen use efficiency (NUE) for Darkhan 141 variety observed in the highest rate (N60). By the way, application of 40 to 60 kg N ha-1 resulted in similar contribution of NUE (42.9 and 43.9%) while the contribution at the highest rate was increased by 1%. On the other hand the highest wheat yield was obtained at 40 kg N ha-1 fertilizer rate, and lowest yield was obtained at 60 kg N ha-1 rate, which indicate that higher rates of N fertilizer should not be applied for wheat at the sowing time.

Table5. *NUE Data of Darkhan 141*

Treatment	Dry matter (kg ha^{-1})	N yield (kg ha^{-1})	Weight % Ndff	% NUE	% Ndff	% Ndfs
20 kg N ha^{-1}	10586.1	161.7	2.40	21.7	4.90	95.1
40 kg N ha^{-1}	11953.3	191.6	11.1	42.9	19.9	80.1
60 kg N ha^{-1}	9458.5	156.5	17.8	43.9	39.4	60.6

The higher grain yield in Darkhan 141 variety at the rate of 40 kg N ha-1 was achieved due to more dry matter content and N accumulation as compared to other rate of N fertilizer level.

CONCLUSION

These results demonstrated the need of at planting application fertilizes to increase the yield and protein content in Mongolian condition.

1. Application of mineral fertilizers during the seedling time of wheat mutant varieties provided statistically higher grain yield when compared to the Control treatments.
2. The most value of grain yield and proteincontent in seed was observed from Darkhan-172 with application of $N_{20}P_{20}K_{18}$.
3. The maximum additional grain yield and protein content were recorded in the $N_{20}P_{20}K_{18}$ treatment for Darkhan-141.

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REFERENCES

[1] Batsukh B, MyagmarsurenYa. (2008) Basis for the research methodology.

[2] Bayarsaikhan B, Tuul D, MyagmarsurenYa (2019) Effect of fertilizers on the soil fertility and wheat yeld, quality

[3] Choijamts A. (2011) Plant fertilizer management. UB.Steve Orloff. (2010) Effect of Nitrogen Fertilization Practices on Spring Wheat Protein Content. 28pp, UCCE Tulare.

[4] MyagmarsurenYa, Tuul D, Bayarsaikhan B (2012) Effect of fertilizer under irrigated condition on yield of wheat and of barley variety. In: Proceeding of international conference on soil of Khakassia, it's cultivating and preserving. Abakan, Russia, pp 159-164

[5] Mineral fertilize use and the environment (2008) FAO.

[6] Hofmann J, Tuul D, Enkhtuya B. (2012) Final report on future nutrient cycling strategies for agriculture in the Kharaa river basin. Internal report for the Mo Mo project, 31 pages, Darkhan.

[7] Hofmann J, Tuul D, Enkhtuya B. (2016) Agriculture in Mongolia under Pressure of Agronomic Nutrient Imbalances and food security demands: A case Study of Stakeholder Participation for future nutrient and Water Resource Management, pp 471-514

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