ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Influence Of Mineral Fertilizers And Growth Regulator Tsetsetse On The Cropping Capacity And Winter Wheat Quality.

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ABSTRACT

A positive influence of mineral fertilizers and of the growth regulator Tsetsetse on productive processes in winter wheat plants has been found. The studies showed that after treating the plants with TSETSET-SE preparation with the use of mineral fertilizers the yielding capacity increase takes place and quality improvement of the experimental crop.

Keywords: wheat, growth regulator, mineral fertilizers, mineral nutrition, yielding capacity, grain quality.

https://doi.org/10.33887/rjpbcs/2019.10.3.24

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ISSN: 0975-8585

INTRODUCTION

Winter grain crops in their biological nature are the most productive among the bread cereals of the first group that is why, the increase of their yielding capacity is of great importance in the grain production gain. The introduction of the most productive crops and varieties, as well as the cultivation technology improvement are referred to a number of the most important reserves of the yielding capacity growth. In recent years in agriculture globally a considerable attention has been paid to the development of technologies of applying physiologically active substances (growth regulators) while cultivating crops and winter wheat as well. Their application is an ecologically safe practice of raising the yielding capacity and produce quality [5, 6].

As a rule, a high potential cropping power of contemporary varieties is not completely utilized, the level of utilization depends on the creation of corresponding organogenesis stages. In the works of many researchers the yielding capacity increase was reported due to the application of mineral fertilizers and growth regulators [1, 3].

OBJECTS AND RESEARCH METHODS

The object of researches was the TseTseTse preparation – a highly efficient growth regulator for applying to winter and spring wheat. It protects grain eared crops from lodging when intensive grain production technologies are used. The active substance – chlormequat chloride (750 g\l), the product form - water soluble concentrate. The preparation solves the problem of crop lodging through uniform shortening of the internode space and giving the stalks additional rigidity. It boosts tillering and increases the growth of productive stalks.

It reduces costs when harvesting crops: the absence of late sprouting; the possibility of direct combine harvesting; an economy of afterharvest grain processing. It raises hardiness of pants to unfavorable factors of the environment: the increase of the root system volume; the stimulation of the root fibrils growth; the mineral nutrition optimization of plants at the expense of the best fixation in the soil. It also has a positive effect on the formation of the yielding capacity structure components. The preparation inhibits biosynthesis of active gibberellins isomers, thus facilitating the shortening of the straw length, a better development of mechanic tissues and increase of the number of productive stalks.

Diammophoska was used as a mineral fertilizer containing N15P15K15 with a mass fraction of sulfur is 10 % and diammophoska N15P15K15 without sulfur. The experimental crop is winter wheat of the variety Biryuza. The winter wheat cultivation technology was based on the agrothechnical practices commonly accepted in the Ulyanovsk region.

The studies were conducted in laboratory and field settings of P.A. Stolypin Ulyanovsk State Agrarian University. The total area of the plot is 40 m^2 (4x10), the registration area - 20 m^2 (2x10), the experiment replication is fourfold, the plot layout is randomized. The soil of the experimental plot is leached black soil of medium thickness with the average content of clay that has the following characteristics: humus content - 4,3 %, mobile compounds of phosphorus and potassium (according to Chirikov) 193 and 152 mg/kg of the soil respectively, the content of mobile sulfur is 4,7 mg/kg of the soil, pH of salt extraction is 5,3.

The protein content in grain was determined according to State standard 10846–91; a mass fraction of gluten was determined according to State standard P 54478 – 2011, the gluten quality was analyzed on the device IDC–3; the registration of factual harvest was carried out in view of the total area of the plot with calculation on 100 % purity and 14 % moisture (State standard 27548-97).

RESULTS AND THEIR DISCUSSION

The purpose of intensive technologies is the maximum realization of the potential cropping capacity of plants. It depends on the key components of the harvest structure: number of productive stalks on the area unit, number of grains in the ear and their weight, absolute grain weight (the weight of 1000 grains). The number of spikelets in the ear demonstrates the maximum potential cropping capacity which is possible under the favorable combination of all the factors influencing the growth and development of plants.

The number of grains in the ear shows a real responsiveness of plants, in this case, to foliar application of mineral fertilizers and growth regulators. We can judge about the plumpness of grain kernels according to the thousand kernel weight. With the formation of the ear and its parts the following conditions of the environment play an important role: the moisture supply and nutritive substances, temperature conditions, lighting patterns and etc. Among the outlined factors the first place goes to moisture which is used by winter wheat in a great amount during its vegetation and particularly at the stage of tillering and ear formation. At the phase of shooting the differentiation of spikelets into flowers starts and the number of grains per ear depends on it. In the period of conducting researches the temperature regime and amount of rainfall during vegetation differed in the years of the studies both in the amount of active temperatures and moisture supply conditions.

The structural analysis of harvest showed a positive influence of the used preparation on all the components of the harvest structure both in contrast to natural soil fertility and to application of mineral fertilizers NPK and NPKS (table 1).

The winter wheat harvest structure analysis showed that favorable soil and climatic conditions of the vegetation period of 2013 – 2014 made it possible to form the greatest number of productive stalks and grains in the ear and the greatest grain weight in an ear and the weight of 1000 grains.

Unfavorable conditions of the vegetation period of 2014 – 2015 contributed to the decline of qualitative values of the harvest structure components. In all the years of the studies the application of mineral fertilizers and growth regulator raised values of the considered indicators.

On average for 2013 – 2015 the number of grains per ear in contrast to natural soil fertility amounted to 26,6 – 27,3 pieces with the grain weight of 0,80 – 0,98 g., in contrast to application of NPK – 32,4 – 33,6 pieces with the grain weight 1,33 – 1,40 g., in contrast to application of NPKS – 35,4 – 37,1 pieces, 1,40 –1,49 g. The best results were obtained while applying mineral fertilizers and growth regulator: in the variant TseTseTse+ NPKS it amounted to 37,1 pieces, the grain weight – 1,49 g., the weight of 1000 grains was 41gr.

Table 1: Influence of the growth regulator TSETSETSE on all the components of the winter wheat harvest structure of the variety Biryuza (on average for 2013–2015).

Variant	Number of productivestalks, pieces for m^2	Number of grains in an ear, pcs.	Grain weight in an ear, gr.	Weight of 1000 grains, gr.
Control group	409,0	26,6	0,80	37,05
TseTseTse	439,0	27,3	0,98	38,00
Control + NPK	461,5	32,4	1,33	38,20
TseTseTse + NPK	478,5	33,6	1,40	39,40
Control + NPKS	489,0	35,4	1,40	38,60
TseTseTse + NPKS	499,5	37,1	1,49	41,00

Thus the application of mineral fertilizers and the growth regulator TseTseTse contributes to the implementation of principles underlying the genetic make-up of plants for the greatest development of yielding capacity components in winter wheat plants.

The yielding capacity of crops including that of winter wheat depends on all physiologic and biochemical processes that take place in plants during ontogenesis. Ontogenesis of plants in all its subsequent stages occurs in a close dependence on the environmental conditions which makes a certain impact on the yielding capacity formation of the crop.

Yielding capacity is the key indicator of field crops which characterizes the efficiency of using various agrothechnical practices and is the main measure while assessing the effect of some factors on crops. The intensity of growth and development of crops and as a result of this, yielding capacity to a great extent are de-

termined with the temperature range and moisture conditions during ontogenesis. One of the factors of reducing this risk is the use of growth regulators and development of plants in the wheat cultivation technology. Pre-sowing treatment of seeds with growth regulators facilitates the stimulation of many growth processes beginning with early stages, the formation of the vigorous vegetative system and a yielding capacity increase of winter wheat.

The application in production of more productive wheat varieties gives a possibility to get a yield increment of 25 – 30 % [2]. Apart from variety peculiarities of crops it is necessary to provide the plants with nutrients during the whole period of vegetation in order to get sustainable, high yields. A positive influence of growth regulators on production processes and yielding capacity of grain crops has been described in the studies of many authors [7].

The data obtained during the years of researches show that the applied new generation growth regulators perceptibly intensify growth and physiological processes, provide better mineral and air nutrition of plants in the course of individual development of winter wheat resulting in a greater yield.

The studies showed that soil and climatic conditions exerted an essential influence on the winter wheat yield amount (table 2). The climatic conditions of 2013 – 2014 were favorable for growth and development of winter wheat in comparison with the previous year, due to this fact the grain yield was much higher.

In the control group it amounted to 3,60 t/ha. Foliage application of the growth regulator Tse Tse Tse in its pure form contributed to the yielding capacity formation of 3,9 t/ha. The use of the preparation after application of NPK and NPKS increased the yield figure by 0,5 t/ha. The greatest yield formed under favorable conditions of the vegetation period of 2013 – 2014.

Table 2: Influence of the growth regulator Tse Tse Tse and mineral fertilizers on the winter wheat yielding capacity of the variety Biryuza, t/ha

Variant	2013- 2014	2014 -2015	Mean value	Increment t/ha
Control	3,60	1,96	2,78	-
Tse Tse Tse	3,90	2,10	3,00	0,22
Control + NPK	4,00	2,31	3,16	0,38
Tse Tse Tse + NPK	4,50	2,95	3,73	0,95
Control + NPKS	3,90	2,49	3,20	0,42
Tse Tse Tse + NPKS	4,40	3,46	3,93	1,15
LSD_{05}	0,30	0,36		

The application of mineral fertilizers and the growth regulator Tse Tse Tse raised the winter wheat yielding capacity in comparison with control variants in all the years of researches which is stipulated by the improvement of plants' mineral nutrition and positive influence on the biomass gain because of the increase of lateral stalks number of winter wheat. On average for two years of researches the yielding capacity in the experiment variants varied between 2,78 and 3,93 t/ha. The use of the growth regulator Tse Tse Tse contributed to the yield increase up to 3,00 – 3,93 t/ha. The greatest gain was achieved in the variant Tse Tse Tse (3,93 t/ha) after the use of NPKS.

Grain quality is the whole complex of biological, physical, chemical and technological properties of grain that determine its usefulness and ability to satisfy certain requirements in conformity with the purpose. Grain quality is a factor of intensifying agricultural production that is why the biochemical properties im-

provement of grain quality has a key importance in the crop growing industry. A positive influence of growth regulators is emphasized by many authors on the basis of their researches.

For grain production the most important indicators of grain quality are protein, gluten, gluten distortion index , starch, volumetric mass, vitreousity.

Grain quality depends on the complex of factors: weather conditions, a soil type, agrothechnical practices, the system of fertilizers, varietal properties of seeds. The quality does not often meet the requirements set to it. The major cause of it is insecure soil and climatic conditions of the Ulyanovsk region. In the course of the studies it was found that the action of investigated mineral fertilizers and growth regulators is not only confined to the yield increase but also exerts a positive influence on the most important indicators of winter wheat grain quality such as: protein content, gluten and gluten index distortion because they determine flour baking properties [4,8].

One of the major indicators of the winter wheat grain quality is the protein content. Protein is a lengthy chain of aminoacids. It is very important that the protein composition and especially the content of so called irreplaceable aminoacids correspond to an organism need of a human or an animal. A deficiency of any important aminoacid leads to the state when only a part of plant aminoacids is used by an animal's organism for protein synthesis, the rest aminoacids are removed or serve as the energy source. Protein is a complicated complex of high molecular organic compounds containing in its composition 53% of carbon, 17% of nitrogen, 7% of hydrogen. A great part of proteins in grain is in endosperm, in a solid form as a reserve substance that makes proteins more resistant to chemical and physical effects.

The amount and quality of protein in the plant depends on many factors and as the studies have shown, weather conditions of the vegetation period have a great importance especially in the period of grain filling. The study results (table 3) demonstrate that the used preparations contributed to the improvement of qualitative indicators of winter wheat grain. On average for the years of the studies under the action of the growth regulator Tse Tse Tse the protein content in winter wheat grain raised by 1,37 % in contrast to natural soil fertility, by 1,60 % – in contrast to NPK, by 1,71 % – in contrast to NPKS. The biggest protein content was in variants of Tse Tse Tse+ NPKS.

Table 3: The relationship between values of grain quality and application of the growth regulator Tse Tse Tse and mineral fertilizers (average for 2013 – 2015)

Variant	Protein, %	Mass fraction of gluten, %	GID, units.
Control	13,28	31,2	47
Tse Tse Tse	14,65	33,3	69
Control NPK	13,99	33,4	64
Tse Tse Tse NPK	15,59	37,6	72
Control NPKS	14,45	34,9	72
Tse Tse Tse NPKS	16,16	40,5	69

One of the indicators of bread baking qualities of grain is the mass fraction of gluten and its quality. Gluten is the highly hydrated resilient (rubberlike) substance washed off finely ground grain. It is mainly composed of imbibed proteins (70 – 80 % on dry matter), starch (about 20 %) and a small amount of other substances (fat, fibre and etc.). Owing to it bread of perfect quality can be produced from wheat.

The mass fraction of gluten is connected with the amount of protein substances. The gluten quality is thought of as the whole complex of its physical properties: stretching capacity, resilience, elasticity, viscosity, cohesion, ability to preserve physical properties with time.

Unfavorable conditions of grain's ripening in an ear and during its storage exert influence on the amount and quality of gluten.

The application of mineral fertilizers and growth regulators throughout all the years of researches exerted a positive influence on the winter wheat yielding capacity both under favorable and unfavorable agroclimatic conditions. The productive process activation ultimately contributed to the grain quality improvement.

In the first year of research the gluten content in grain without applying fertilizers on the control field amounted to 28,6 %, application of the growth regulator Tse Tse Tse increased the values up to 30,4 %. After application of mineral nutrition the content of the considered indicator increased up to 31,1 (in control) – 35,8 % (Tse Tse Tse), the quality herewith corresponded to group I was equal to 61 and 69 units of the gluten index distortion, respectively. The values with the use of NPKS were higher than that of the previous fertilization by 1,8 -2,5 %. Maximum values were determined on the variant Tse Tse Tse (37,6 %) after fertilization with NPKS. The quality herewith corresponded to group I and was equal to 68 and 72 units of the gluten index distortion. In 2014 – 2015 the gluten content in the variant Tse Tse Tse in the corresponding fertilization types the highest values were obtained – 36,1 - 39,4 – 43,3 %.

The mass gluten content in winter wheat grain on average for two years of researches fluctuated from 31,2 % (control) up to 40,5 % (Tse Tse Tse+NPKS). Foliage application of the preparation raised this value by 2,1 % in comparison with the control variant. When this preparation was used after fertilization with mineral fertilizers (NPK) its amount increased by 4,2 %, after NPKS – by 5,6 %. Maximum values of the determined indicator were obtained in the variant Tse Tse Tse+ NPKS which was 40,5 %, the quality herewith corresponded to group I and was equal to 69 units of the gluten index distortion.

CONCLUSIONS

Thus the use of mineral fertilizers and the growth regulator Tse Tse Tse in the winter wheat cultivation technology contributed to a yielding capacity increase and grain quality of winter wheat. The combination of the studied factors secured a higher level of plant nutrition during the whole vegetation period of the crop which was the basis of a more complete utilization of genetic potential of the plants' cropping power.

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