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VARIATION OF QUANTITY OF STALKS M^{-2} TRAIT OF WINTER WHEAT (*TRITICUM AESTIVUM* L.) VARIETIES UNDER THE INFLUENCE OF DIFFERENT TREATMENTS.

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ABSTRACT
This investigation was carried out in three winter varieties namely Batko, Deya and Krasnodarskaya 99 at bushing-out – harvest output phase to study the effect of growth regulator, Furolan and mineral fertilizer on quantity of stalks m^{-2} trait in these plants. The quantity of productive stalks per unit area of winter wheat is one of the basic quantitative characteristics of assessing grain productivity. At the end of bushing-out phase, Deya generated 761 stalks, while Krasnodarskaya 99 had 759 pieces m^{-2}. In the control the number of stalks m^{-2} produced by the three varieties on the average comprised 731 pieces however, in the fertilized variant about 873 pieces m^{-2} were produced. With the application of only the growth regulator, the quantity of plants m^{-2} increased by 4 pieces to a total of 333 pieces. This increase was statistically significant (LSD_{05} – variants = 3.62). In the variant without fertilizer in Bat'ko variety bushiness was 2.2, but on application of only growth regulator, Furolan there was no change as it recorded 2.2 plant stalks. From this result, it appeared biological activity did not affect bushiness on the application of growth regulator in the harvest output phase.

KEYWORDS: Wheat, Field-germinating power, Quantity Of Stalks m^{-2}, Bushing-out – harvest output phase**,** Plant bushiness trait.

1.0 INTRODUCTION
The quantity of productive stalks per unit area of winter wheat is one of the basic quantitative characteristics of assessing grain productivity. However, productivity of winter wheat grain is an integral, multiple quantitative trait which depends on many factors including: productive bushiness, numbers of productive stalks per m^2, grain number and weight ear^{-1} and plant^{-1}, ear sterility, and also of 1000‒ grain weight. These are the basic traits which form or contribute to yield (Araus et al., 1993). The wheat plant has the ability to tiller, i.e. to produce lateral branches. At the end of the vegetative phase of development, the plant will consist of, in addition to the main shoot, a number of tillers. Exactly how many are present at this stage varies widely depending on factors such as plant population, sowing date, mineral nutrition and the application of plant growth regulators. Classification systems generally either number the tillers in a series, starting at the coleoptile tiller (the first potential tiller) or identify tillers with reference to the leaf in whose axil they appear (Peterson *et al*., 1982; Kirby and Appleyard, 1987; Spilde, 1989)). In the latter system, which leads to least confusion, the main shoot (MS) bears primary tillers in the axils of its leaves (Tl in the axil of leaf 1, T2 in the axil of leaf 2, and so on). The tiller borne in the axil of the coleoptile is termed TC (TO by some such as Peterson *et al*., 1982). Each primary tiller has a potential to bear a number of secondary tillers; these are similarly labelled with reference to the primary tillers, e.g. Tl1 is the tiller borne in the axil of leaf 1 of tiller 1. The tiller borne in the axil of the prophyll is coded P: thus TCP is the tiller in the axil of the prophyll of the coleoptile tiller. The system can easily be extended to higher-order tillers (e.g. tertiary tillers, T111 or fourth-order tillers, T1111 and so on). In this study, the aim is to determine the effect of growth regulator, Furolan and mineral fertilizer on the following traits; quantity of productive stalks / plants m^{-2} of three winter varieties at bushing-out – harvest output phase.

2.0 MATERIAL AND METHOD
The tests were carried out in the field conditions of the experimental field of All-Russian Rice Research Institute, Belozerny, Krasnodar, Russia from 2007 to 2009. In this study, the dynamics of the formation of productive stalks of winter wheat varieties of Bat'ko, Deya and Krasnodarskaya 99 under the effect of various doses of mineral fertilizers was investigated according to the following scheme : $N_{50}P_{90}K_{40}$ for the basic soil treatment plus N_{60} – top-dressing in spring and N_{30} ‒ foliar top-dressing during the ear formation phase.

During the elongation phase, towards the time of harvest, the winter wheat plants were sprayed (at the rate of 300 dm^3/hectare) with 5 g/hectare dose of Furolan (growth regulator) in water solution with the aid of dosimeter device.

Winter wheat varieties were sown according to the fertilizer variants at the end of September. The experimental plot was 3 m x 8 m = 24 m^2 in three replicates. The plots were completely randomized. The seeds were sown − 5 million grains per hectare. The precursor plant was winter barley.

After 7- 9 days appeared the shoots of winter wheat varieties. 10 days after the appearance of the shoots, an assessment of the quantity of plants m^{-2} was carried out from which, the value of field germinating power of the seeds of each variety per experimental variant was equally determined. After 20 days of the appearance of the shoots which coincided with the first 10 days of November, the quantity of plants and number of stalks m^{-2} were assessed and recorded. From these results, the plant bushiness was calculated. The results were processed with statistical method for analysis of variance, and differences were tested by LSD-test.

3.0 RESULTS AND DISCUSSION

Table 1: **Data on field germinating power and bushiness of winter wheat varieties for various doses of mineral fertilizers for the period up to winter- break (2007-2009)**

Variety (factor A)	Dose of Mineral fertilizers, kg added per hectare (factor B)	Shoots		Number of stalks m^{-2} piece^{-1}	Bushiness
		Quantity of plants m^{-2}, piece^{-1}	Field germinating power, %		
Bat'ko	Control	390	78.0	858	2.2
	$N_{50}P_{90}K_{40}$	413	82.6	1032	2.5
Deya	Control	380	76.0	798	2.1
	$N_{50}P_{90}K_{40}$	395	79.0	948	2.4
Krasnodar-skaya 99	Control	385	77.0	770	2.0
	$N_{50}P_{90}K_{40}$	407	81.4	936	2.3
$LSD_{0.05}$		2.34		4.11	0.17

3.1 Bushing–out phase of plants

3.1.1. Quantity of plants m^{-2}

Field germinating power of seeds of winter wheat varieties varied from 76 % in the control of Deya variety to 82.6 % in Bat'ko variety in the fertilized variant (Table 1). Winter wheat varieties showed weak response to mineral fertilizers during germination of seeds and formation of shoots (van Oosterom and Acevedo, 1992). Response indices in these varieties were low and varied from 1.03 (in Deya variety) to 1.06 (in Bat'ko and Krasnodarskaya 99).

On the basis of two-factorial dispersion analysis of the number of plants and quantity of stalks m^{-2} according to the significance of dispersion types the effect of each type of variation according to the magnitude of traits investigated was determined. The effect of the general variation on field germinating power of plants amounted to 35.9 %.

The effect of variants on number of erect plants amounted to about 31.8 %. The effect of genotypes of the varieties (factor A) on the formation of plant density after sprouting amounted to 7.6 %. This was relatively a weak effect. The effect of mineral fertilizers on field germinating power was 23.3 %. This was a strong effect by fertilizers which led to stimulation of growth processes in seed germination (Evans, 1993).

3.1.2 Number of shoots m^{-2}

Towards the end of winter, the quantity of stalks and plant bushiness were estimated. The number of stalks m^{-2} in the fertilized variant was statistically more significant than the control. At the end of autumn the plant bushiness varied from 2.0 to 2.5 (Table 1).

In February nitrogen top-dressing dose of N_{60} kg per 1 hectare was added. After cultivation of the spring vegetation, the quantity of winter-surviving plants was estimated (Table 2).

Table 2: Data on the formation of vegetative stalks in spring bushing-out phase (2007- 2009)

Variety (factor A)	Dose of Mineral fertilizers, kg added per 1 hectare (factor B)	Remaining surviving plants after winter		Number of stalks m^{-2}, per piece	Number of plants at the end of bushing-out, piece m^{-2}	Coefficient of bushing-out
		Plants, piece m^{-2}	Surviving plants, %			
Bat'ko	Control	337	86.4	797	335	2.4
	$N_{50}P_{90}K_{40} + N_{60}$	365	88.4	975	363	2.7
Deya	Control	315	82.9	684	312	2.2
	$N_{50}P_{90}K_{40} + N_{60}$	339	85.8	837	335	2.5
Krasnodar Skaya 99	Control	326	84.7	711	322	2.2
	$N_{50}P_{90}K_{40} + N_{60}$	338	85.1	806	334	2.4
LSD_{05}		19.17		24.81	18.32	0.19

Bat'ko variety in two experimental variants on the average produced 886 stalks m^{-2}. At the end of bushing-out phase, Deya generated 761 stalks, while Krasnodarskaya 99 had 759 pieces m^{-2}. In the control, the number of stalks m^{-2} produced by the three varieties on the average was 731 pieces however, in the fertilized variant 873 pieces m^{-2} were produced.

3.1.3 Plant bushiness

Bushing-out coefficient varied from 2.2 in the control of Deya and Krasnodarskaya 99 to 2.7 in the fertilised variant of Bat'ko variety. Mineral fertilizers significantly increased the bushiness in all the varieties of winter (soft) wheat studied (Haun**,** 1973).

3.2 Harvest output phase

Top-dressing with growth regulator, Furolan was carried out at the beginning of the harvest output phase. At this stage, this study was investigated on three-factorial basis namely: factor A – cultivar or variety; factor B – mineral fertilizer; factor C – growth regulator, Furolan. Thus, the effect or non-effect of all the variants in this investigation was analyzed at the three-factorial level.

3.2.1 Quantity of plants m^{-2}

The quantity of plants in all varieties increased under the effect of mineral fertilizer and growth regulator. In the control of Bat'ko variety all the experimental variants recorded 329 pieces m^{-2} on the average for three years. With the application of growth regulator only, the quantity of plants per m^2 increased by 4 pieces to a total of 333 pieces. This increase was statistically significant (LSD_{05} – variants = 3.62). Application of mineral fertilisers $N_{50}P_{90}K_{40}$ + N_{60} in spring resulted in an increase of 25 pieces in the quantity of plants to a total of 354 pieces m^{-2}. By applying both mineral fertilizer and growth regulator, Furolan of 5g/ hectare dose the quantity of plants increased by 39 pieces to a total of 368 pieces m^{-2}. A similar trend of increase in number of pieces was observed in the other varieties- Deya and Krasnodarskaya 99.

Table 3: **Data on the effect of different doses of mineral fertilizers and growth regulator on variation of quantity of plants of (soft) winter varieties in the harvest output phase, pieces m^{-2} (2007−2009)**

Variety (factor A)	Dose of Mineral fertilizers, kg added per 1 hectare (factor B)	Growth regulator (factor C)	Average for:						
			Variants	A	B	C	AB	AC	BC
Bat'ko	Control	control	329		321			341	317
		Furolan	333				331	350	325
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	354	346	345		361		338
		Furolan	368						351
Deya	Control	control	305					317	
		Furolan	314				309	327	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	330	322			335		
		Furolan	341						
Krasnodar-skaya 99	Control	control	317					323	
		Furolan	329				323	337	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	330	330		328	337		
		Furolan	345			338			
LSD_{05}			3.62	**1.81**	**1.48**	**1.48**	**2.56**	**2.56**	**2.09**

For factor A (variety) the quantity of plants m^{-2} reduced from an average of 346 pieces (Bat'ko variety); 322 pieces (Deya variety) to 330 plants (Krasnodarskaya 99), (LSD_{05}− variant = 1.81).

For factor B (mineral fertilizer) quantity of plants m^{-2} varied from an average of 321 pieces (control) to 345 pieces (mineral fertilizer). The difference between fertilized variant and control on the average amounted to 24 plants per m^2 (LSD_{05} – factor B = 1.48). For factor C (growth regulator) the quantity of plants m^{-2} varied from 328 pieces (without application of growth regulator, Furolan) to 338 pieces (with growth regulator).

From these results, it could be reasoned that the interaction of growth regulator with genotypes of cultivars and doses of mineral fertilizers helped to protect the plants from death during the harvest output phase (Evans et al.,1975; Farquhar and Richards, 1984).

By means of three-factorial dispersion analysis of the number of plants on the basis of dispersion types the effects of the different variations by magnitude of traits formed were determined. For example, the effect of general variation on the formation of plant number m^{-2} was 34.5%. The number of plants m^{-2} enhanced by the effect of experimental variants (genotypes of varieties, doses of mineral fertilizer and growth regulator) was 33.0% (Wuest and Cassman, 1992).

The effect of factor A on the formation of plant number m^{-2} was to 11.3% while the effect of factor B (mineral fertilizer doses) on the density of plants m^{-2} was 16.4%. Mineral fertilizer exhibited some stimulating effect on the plants at the harvest output phase (Harris, 1991;

Sowers et al., 1994). The effect of factor C (growth regulator) on the formation of number of plants was 3.4%. This weak effect of growth regulator, Furolan in the formation plant number m^{-2} could be explained thus; that at the output phase the application of foliar top-dressing of growth regulator in 5g/hectare dose , did not have effect on the growth processes of winter wheat varieties as well as density sustenance of cenosis of each plot (Wardlaw, 1980).

3.2.2. Quantity of stalks m^{-2}

In the harvest output phase the number of stalks m^{-2} of winter wheat varieties under the effect of doses of mineral fertilizer and growth regulator were determined as recorded in Table 4 .

Table 4: **Data on the effect of different doses of mineral fertilizers and growth regulator, Furolan on variation of quantity of plants of (soft) winter varieties in the harvest output phase, pieces m^{-2} (2007−2009).**

Variety (factor A)	Dose of Mineral fertilizers, kg added per 1 hectare (factor B)	Growth regulator (factor C)	Average for:						
			Variants	A	B	C	AB	AC	BC
Bat'ko	Control	Control	720					800	653
		Furolan	731		671		725	841	690
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	880	821			916		784
		Furolan	952		811				838
Deya	Control	control	607					679	
		Furolan	655				631	717	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	752	699			766		
		Furolan	780						
Krasnodar skaya 99	Control	control	631					675	
		Furolan	685				658	733	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	720	705		718	751		
		Furolan	782			764			
LSD_{05}			2.31	**1.16**	**0.94**	**0.94**	**1.64**	**1.64**	**1.34**

In harvest output phase, plants of winter wheat varieties were observed to have formed stems, attained the bushing-out stage and started forming the reproductive organs(Wuest and Cassman, 1992). It was also observed that the test or experimental variants in all the varieties increased more in the number of stalks than in the control.

The control of Bat'ko variety had 720 stalks m^{-2}. But with the application of foliar top-dressing of Furolan it produced 11 stalks more than the control amounting to 731 stalks (LSD_{05} – variant = 2.31). In fertilized variant with dose of $N_{50}P_{90}K_{40}$ + N_{60} in spring 880 pieces m^{-2} were produced, but with the combined effect of mineral fertilizer and growth regulator, Furolan the stalk number m^{-2} produced were 952 pieces. For the other varieties, the same trend was observed (Table 4) (Allison and Daynard, 1976).

For factor A (variety) in Bat'ko variety stem number m^{-2} in all the experimental variants on the average was 821 pieces; in Deya variety – it was 699 pieces; Krasnodarskaya 99 – 705 stalks (LSD_{05} – factor A = I.16). For factor B (mineral fertilizer) the number of stalks m^{-2} varied from 671 pieces (control) to 811 pieces (fertilizer variant), (LSD_{05} –factor B = 0.94). For factor C (growth regulator) number of stalks per m^2 varied from 718 pieces (control) to 764 pieces (fertilizer variant).

The effects on formation of stalks were determined on the basis of three-factorial dispersion analysis according to the magnitude of dispersion types. The effect of the general variation on the production of stems amounted to 33.3%. The effect of experimental variants on the formation of stalk number in 1 m^2 amounted to 33.3% while the effect of factor A (variety) on the formation of stems amounted to 11.6%. The formation of these additional stalks seemed to rest on the genotypic characteristic (Allison and Daynard, 1976). The effect of factor B (doses of mineral fertilizers) on formation of stalks of winter wheat varieties amounted to 17.9%. This showed a good response of the plants of winter wheat varieties to mineral fertilizers. In Bat'ko variety the response index to mineral fertilizer amounted to 13.2; Deya – 12.9 and Krasnodarskaya 99 – 12.4.

The effect of factor C (growth regulator) on formation of stalks was 1.9%. This was a very weak effect. Even when the growth regulator was introduced in the harvest output phase, it still did not show any stimulating effect.

3.2.3 Plant Bushiness

In the output phase that proceeded the autumn and spring bushing-out phases it was observed, that plants of winter wheat varieties had high bushiness during the harvest period. However, growth and development of the plants continued into the fruiting stage (Sofield, 1977). The yield potential was laid at this period.

From the spring bushing-out to the harvest output phase, reduction in the number of plants and stalks m^{-2} was observed and consequently a reduction in the coefficient of bushing-out (Austin,1990).

In experimental variants of Bat'ko variety bushiness varied from 2.2 (control) to 2.6 (variant of combined application of mineral fertilizer and growth regulator).

In the variant without fertilizer in Bat'ko variety bushiness was 2.2, but on application of only growth regulator, Furolan there was no change as it recorded 2.2 plant stalks. It appeared biological activity did not alter bushiness on application of growth regulator in the harvest output phase. This was why it was the same with the control (Table 5).

Table 5: **Data on the effect of various doses of mineral fertilizers and growth regulator on variation of plant bushiness of (soft) winter varieties in the harvest output phase, pieces m^{-2} (2007−2009).**

Variety (factor A)	Dose of Mineral fertilizers, kg added per hectare (factor B)	Growth regulator (factor C)	Average for:						
			Variants	A	B	C	AB	AC	BC
Bat'ko	Control	control	2.2		2.1			2.3	2.1
		Furolan	2.2				2.2	2.4	2.1
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	2.5	2.4	2.4		2.5		2.3
		Furolan	2.6						2.4
Deya	Control	control	2.0					2.1	
		Furolan	2.1				2.1	2.2	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	2.3	2.2			2.3		
		Furolan	2.3						
Krasnodar-skaya 99	Control	control	2.0					2.1	
		Furolan	2.1				2.1	2.2	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	2.2	2.1		2.2	2.3		
		Furolan	2.3			2.3			
LSD_{05}			0.14	**0.07**	**0.06**	**0.06**	**0.10**	**0.10**	**0.08**

In experimental variants of Krasnodarskaya 99 bushiness varied from 2.0 (control) to 2.3 (combined action of mineral fertilizer and Furolan). In this case, the action of growth regulator, Furolan could be considered as preserving the bushiness of plants but not as a stimulator. For factor A (variety) bushiness varied from 2.1 (Krasnodarskaya 99); 2.2 (Deya) to 2.4 (Bat'ko).

For factor B (mineral fertilizer) bushiness in all the experimental variants varied on the average from 2.1 (control) to 2.4 (mineral fertilizer).

For factor C (growth regulator) bushiness varied from 2.2 (control) to 2.3 (mineral fertilizer + Furolan), (LSD_{05} – factor C = 0.07).

The effects of different types of variation in the formation of bushiness in the harvest output phase of plants were determined. The effect of general variation on bushiness was 36.4% while the effect of experimental variants on formation of bushiness was 30.6%. On the other hand, the effect of factor A (variety) in bushiness of winter wheat varieties was 9.7%. This was purely a significant genetic characteristic of the variety. Also, the effect of factor B (doses of mineral fertilizer) in bushiness amounted to 17.5%. This was a significant effect in the formation of bushiness. Mineral fertilizers, applied as basic soil treatment and spring top-dressing with dose of nitrogen N_{60} essentially influenced the production of surplus plant stalks (Baker and Gallagher,1983; Cutforth et al., 1992). Effect of factor C (growth regulator) in the formation of bushiness was only 1.0%.The explanation for the weak impact of growth regulator, Furolan on the production of stalks in the plants of winter wheat varieties could not be unconnected to its application in the harvest output phase.

4.0 CONCLUSION

The quantity of productive stalks per unit area of winter wheat is one of the basic quantitative characteristics of assessing grain productivity. The manifestation of this trait depends on a number of factors namely; productive bushiness, numbers of productive stalks per m^2, grain number and weight ear^{-1} and $plant^{-1}$, ear sterility, and also of 1000− grain weight. In this study it was generally observed that the quantity of plants per unit area in all the varieties increased differently under the effect of mineral fertilizer and growth regulator at harvest output phase.

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