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VARIATION OF QUANTITY OF STALKS- AND PLANTS- M^{-2} AND PLANT BUSHINESS TRAITS OF WINTER WHEAT (*TRITICUM AESTIVUM* L.) VARIETIES UNDER THE EFFECT OF DIFFERENT TREATMENTS AT EAR-FORMATION PHASE.

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ABSTRACT

This investigation was carried out to study the effect of growth regulator, Furolan and mineral fertilizer on the traits; quantity of stalks / plants m^{-2} and plant bushiness at ear-formation phase in three winter wheat varieties namely Batko, Diya and Krasnodarskaya 99. By means of three-factorial dispersion analysis the influence of different kinds of variation on the formation number of productive stalks m^{-2} was determined. The number of productive stalks m^{-2} subjected to the effect of factor A (variety) varied as follows: Deya (653 stalks); Bat'ko (661 stalks) and Krasnodarskaya 99 (679 pieces). For factor B (mineral fertilizer) the number of productive stalks varied from 614 pieces (control) to 715 pieces m^{-2} (full dose of mineral fertilizer). The difference between control and the fertilized variants was 101 stalks m^{-2} (LSD_{05}-factor B = 8.25). However, for factor C (growth regulator) the amount of productive stalks varied from 644 pieces (without treatment) to 685 pieces m^{-2} (Furolan –treated plants at the harvest output phase). The difference in these variants on the average was 41 stalk m^{-2} (LSD_{05} − factor C = 8.25).

KEYWORDS: Wheat varieties; Mineral fertilizer; Furolan; Quantity Of Stalks / Plants m^{-2}; Plant Bushiness**;** Ear-Formation Phase.

1.0 INTRODUCTION

At the ear formation phase the plants of winter wheat varieties have already formed the productive stalks and reached the fruition stage. All the organs and ear parts in the plants such as; the number of cones, spikelet and floral scales are already formed. In the stamens, pollen grains are formed by the process of meiosis. The germinal sac is formed in the ovaries and the plants begin to form spikes.

Spikelet number per spike is already determined at this stage, varying from 20 to 30 (Araus, 1993; Kirby, 1993 and Rees, 1993) reported a positive correlation between the length of the vegetative phase and the number of spikelets per spike; lengthening the duration of the vegetative stage of the apex induces more spikelets per spike. However, the actual number of spikelets is determined by the length of the reproductive phase. Short days (eight hours) from double ridge to terminal spikelet initiation stimulate a large number of spikelets (Rawson, 1971; Rahman and Wilson, 1978).

Towards the end of this stage, the apex, which is beneath the soil surface, starts to grow faster and rise (Pollock et al., 1984). This stage is particularly sensitive to environmental stresses, especially nitrogen and water (Schachtman, 1992). Therefore, terminal spikelet has been suggested as the stage at which the second dose of nitrogen fertilizer should be applied (Biscoe, 1988) and as an indicator of the limit for using growth regulator herbicides (Shpiler and Blum, 1986).

Once the terminal spikelet is formed, stem elongation starts and the spike begins to grow. Spike growth occurs from the appearance of the leaf prior to the flag leaf (penultimate leaf) up to ten days past anthesis (Richards, 1996). Spike growth, slow in its early stages, increases greatly about the time the ligule of the flag leaf becomes visible (Krumm *et al*., 1990). Floret abortion starts in the boot stage and finishes at anthesis.

In the soil by this time the plants utilized, to a large measure, very vital nutritive elements leading to a reduction in the amount of available moisture resulting in damages and diseases to the plants. All these negative factors lead to the partial destruction of individual plants or dying-off of the stalks. This results ultimately in a reduced amount of productive stalks and lower yield.

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. Winter wheat varieties were sown according to the fertilized 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.

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.

Thus, according to the scheme of our study, foliar spraying of ammonium saltpetre in dose of N_{30} kg. per hectare was carried out at this time. The results obtained were processed with statistical method for analysis of variance and differences were tested by LSD-test.

3.0 RESULTS AND DISCUSSION

3.1 Quantity of plants m^{-2}

The quantity of plants m^{-2} in experimental variants of Bat'ko variety varied from 296 pieces (in control) to 325 pieces (in fertilized variant + Furolan). In the control of Bat'ko variety there were 296 plants m^{-2}, but with application of only mineral fertilizer, the quantity increased by 21 plants to 371 pieces.

By the application of growth regulator, Furolan the quantity of plants m^{-2} in comparison with control increased by 14 pieces (Table 1). It could be deduced here that the increase was not only in plant quantity m^{-2} but due to storage towards the ear-formation phase. In the combined variant i.e mineral fertilizer + growth regulator, Furolan the quantity of plants m^{-2} increased to 325 pieces; 29 pieces more than the control (LSD_{05} – variant = 5.31)

The same trend was observed in the other varieties: an increase in the quantity of fertilizers resulted to significant increase in the amount of plants per m^2 in the experimental variants (Wyn and Gorham, 1991).

For factor A (variety) the quantity of plants varied from 307 pieces (Deya); 312 pieces (Bat'ko) to 315 pieces (Krasnodarskaya 99).

For factor B (mineral fertilizer) the quantity of plants of winter wheat varieties varied from 300 pieces (control) to 322 pieces m^{-2} – of the fertilized variant. The difference between fertilized variant and control on the average was 22 plants m^{-2} (LSD_{05} – factor B = 2.17).

Table 1: Data on the effect of different doses of mineral fertilizers and growth regulator on variation of quantity of plants of (soft) winter wheat varieties at the ear-formation 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	296		300		303		394
		Furolan	310					307	310
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	317	312	322		321		317
		Furolan	325					317	325
Deya	Control	control	292						
		Furolan	302				297	304	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	315	307			317		
		Furolan	319					311	
Krasnodar-skaya 99	Control	control	293						
		Furolan	308				301	310	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	326	315		307	329		
		Furolan	331			316		320	
LSD_{05}			5.31	**2.66**	**2.17**	**2.17**	**3.75**	**3.75**	**3.07**

For factor C (growth regulator) the plant quantity m^{-2} varied from 307 pieces (without treatment) to 316 pieces (with foliar spraying of Furolan). The difference between variants was 9 plants m^{-2} (LSD_{05} – factor C = 2.17).

Thus, mineral fertilizers and growth regulator enhanced growth of the winter wheat varieties to the ear formation phase (Venora and Calcagno, 1991).

Using the 3-factorial dispersion analysis the effects of the different dispersion types on the formation of plant number m^{-2} were determined.

The effect of the general variation in the conservation of plant number m^{-2} was 35%. while that of experimental variants on plant quantity m^{-2} formation was 32.8%. However, the effect of factor A (variety) on the formation of plant density was 3.1%. At the ear-formation phase potential possibilities of the genotypes of the varieties had already been exhausted and the conservation of the number of plants proceeded only at the expense of the soil fertility.

The effect of factor B (doses of mineral fertilizer) on the formation of the plant number m^{-2} was 24.6%. This effect was significant in the sustenance of plant number per m^2 during the ear formation phase.

The effect of factor C (growth regulator) in the sustenance of plant density altogether was 4.4%. This effect was weak. Here, it could be seen that the effect of the mineral fertilizer was the most domineering of all the regulatory factors.

3.2 Stalk number m^{-2}

The most valuable trait which accounts for yield of variety based on formation and weight of grains ear^{-1} is the number of productive stalks m^{-2} (Slafer and Rawson, 1994).

In the experimental variants the number of productive stalks increased with rise in dose of mineral fertilizer and growth regulator (Table 2).

In experimental variants of Bat'ko variety the number of productive stalks m^{-2} varied from 592 pieces (control) to 723 pieces m^{-2} (variant treated with mineral fertilizer and Furolan). The difference between fertilizer variant and control was 131 stalk m^{-2} (LSD_{05} – variant = 20.22).

A distinct statistical significance was established in all the experimental variants of Bat'ko variety in respect to increase in the number of productive stalks m^{-2}. A similar pattern was observed in the other winter wheat varieties.

Table 2: Data on the effect of various doses of mineral fertilizers and growth regulator on variation of quantity of productive stalks of (soft) winter wheat varieties at the ear-formation 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	592		614		612		590
		Furolan	632					645	638
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	698	661	715		711		679
		Furolan	723					778	732
Deya	Control	control	591				613		
		Furolan	634					633	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	674	653			694		
		Furolan	713					674	
Krasnodar-skaya 99	Control	control	587				618		
		Furolan	648					653	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	719	679		644	740		
		Furolan	761			685		705	
LSD_{05}			20.22	**10.11**	**8.25**	**8.25**	**14.30**	**14.30**	**11.67**

The number of productive stalks m^{-2} in factor A (variety) varied in the following sequence: Deya (653 stalks); Bat'ko (661 stalks) and Krasnodarskaya 99 (679 pieces).

For factor B (mineral fertilizer) the number of productive stalks varied from 614 pieces (control) to 715 pieces m^{-2} (full dose of mineral fertilizer). The difference between control and the fertilized variant was 101 stalks m^{-2} (LSD_{05}-factor B = 8.25).

However, for factor C (growth regulator) the amount of productive stalks varied from 644 pieces (without treatment) to 685 pieces m^{-2} (Furolan – treated plants at harvest output phase). The difference in these variants on the average was 41 stalk m^{-2} (LSD_{05} − factor C = 8.25).

Effects of different kinds of variation on the formation productive stalks of winter wheat varieties were determined by means of three-factorial dispersion analysis according to the significance of dispersion types. From this study, it was established that the effects of the general variation on the formation of number of productive stalks m^{-2} was 33.2 %. The effects of experimental variants on productive stalks of winter wheat varieties ear-formation phase was 33.0 %. The effect of factor A (variety) on formation of productive stalks was 12.2 %. This showed strong effect of the genotypes of cultivars on the plant growth process and development (Sowers et al., 1994). Optimal productive stalks were generated which positively influenced productivity of winter wheat varieties. The effect of the factor B (mineral fertilizer) in the formation of number of productive stalks of winter wheat varieties was 20.0 %. Mineral fertilizers increased the productive stalks. The effect of the factor C (growth regulator) on formation productive cenosis was only 1.5 %. In this case, one might say that there was partial increase of stalks in plants under the influence of growth regulator. The ear-formation phase of winter wheat varieties in the Central zone of Krasnodar territory occurred in the first-second ten days of the month of May. By this time, the major part of the soil nutrients had been assimilated by the plants, humidity decreased; death and diseases had taken the place of competitive interrelation among the plants. All this as a whole negatively affected formation of stalks in cenosis which led to reduced bushiness in comparison with harvest output phase.

3.3. Bushiness of plants

Bushiness of plants varied weakly depending on doses of mineral fertilizers and growth regulator. In the control and variant without fertilizer of Batko variety, but Furolan-treated bushiness was similar amounting to 2.0 stalks per plant. The growth regulator applied at the harvest output phase of plants seemed not to have positive influence in the number of productive stalks in a plant. Mineral fertilizers without growth regulator partially increased productive stalks and bushiness (Table 3).

Table 3: Data on the effect of different doses of mineral fertilizers and growth regulator on variation of productive bushiness of (soft) winter wheat varieties at the ear-formation phase, pieces plant^{-1} (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	2.0		2.0		2.0		2.0
		Furolan	2.0					2.1	2.0
	$N_{50}P_{90}K_{40}$ + N_{60}in the spring	control	2.2	2.1	2.2		2.3		2.2
		Furolan	2.3					2.2	2.3
Deya	Control	control	2.0				2.1		
		Furolan	2.1					2.1	
	$N_{50}P_{90}K_{40}$ + N_{60}in the spring	control	2.1	2.1			2.2		
		Furolan	2.3					2.2	
Krasnodar-skaya 99	Control	control	2.0				2.1		
		Furolan	2.1					2.1	
	$N_{50}P_{90}K_{40}$ + N_{60}in the spring	control	2.2	2.1		2.1	2.3		
		Furolan	2.3			2.2		2.2	
LSD_{05}			0.06	**0.03**	**0.02**	**0.02**	**0.04**	**0.04**	**0.03**

In Bat'ko variety it (bushiness of plants) varied from 2.2 (mineral fertilizer) to 2.3 (mineral fertilizer + Furolan). The difference between control and the fertilizer variants was 0.3 (LSD_{05}-variant = 0.06).

For factor A (variety) in all varieties in ear-formation phase bushiness on the average was similar amounting to 2.1. For factor B (mineral fertilizer) bushiness of plants varied from 2.0 (control) to 2.2 (mineral fertilizer), (LSD_{05}-factor B = 0.02). Mineral fertilizer significantly affected and increased bushiness of winter wheat varieties.

For factor C (growth regulator) bushiness varieties on the average varied from 2.1 to 2.2. The growth regulator, Furolan did not influence increase in the number of stalks in plant, but merely supported them especially at harvest output phase of plants. Growth of productive stalks was also enhanced by Furolan which directly increased bushiness.

Analyzing the results of interaction of factors A and C of productive bushiness traits in ear-formation phase of plants, it was observed that all varieties studied responded equally to the application of growth regulator (Stapper and Fisher, 1990). In control (without Furolan) of all varieties bushiness was 2.1 stalks per plant. On the application of Furolan, bushiness was 2.2 (LSD_{05}-factor AC = 0.04). The growth regulator, Furolan statistically significantly increased the quantity of stalks plant^{-1} (bushiness).

By means of three-factorial dispersion analysis the effect (influence) of different kinds of variation on the formation productive bushiness was determined. The effect of the general variation on formation of bushiness was an average of 38.0 %. The effect of experimental variants resulted in additional stalks per plant which amounted to 26.9 %.

The effect of the factor A (variety) was good resulting to increase in additional stalks at the ear-formation phase amounting to 11.9 %. The effect of the factor B (doses of mineral fertilizer) was strong as it caused increased bushiness of 20.5 %. Response index of the wheat varieties to doses of mineral fertilizers was average of 1.1. The effect of the factor C (growth regulator) in formation of productive bushiness was weak at 2.6 % which enhanced bushiness in ear-formation phase.

4.0 CONCLUSION

It was observed in this study that growth regulator, Furolan and mineral fertilizer separately or combined generally affected the following traits; quantity of stalks / plants m^{-2} and plant bushiness at ear-formation phase of winter wheat in three winter varieties namely Batko, Diya and Krasnodarskaya 99. The quantity of plants m^{-2} in experimental variants of Bat'ko variety varied from 296 pieces (in control) to 325 pieces (in fertilizer variant with mineral fertilizer + growth regulator). In the control of Bat'ko variety there were 296 plants m^{-2}, but with application of only mineral fertilizer, the quantity was more by 21 plants which amounted to 371 pieces. However, the bushiness of plants varied weakly depending on doses of mineral fertilizers and growth regulator. In the control and fertilized variant of Batko variety treated with Furolan bushiness responded similarly amounting to 2.0 stalks per plant.

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