ejpmr, 2016,3(2), 1-6

SJIF Impact Factor 2.026

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH
www.ejpmr.com

Research Article
ISSN 3294-3211
EJPMR

THE EFFECTS OF DIFFERENT TREATMENTS ON VARIATION OF QUANTITY OF STALKS- / PLANTS- M^{-2} AND BUSHINESS TRAITS OF WINTER WHEAT (*TRITICUM AESTIVUM* L) AT FULL RIPENESS PHASE.

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Article Received on 22/11/2015 **Article Revised on 13/12/2015** **Article Accepted on 2/1/2016**

ABSTRACT

This study was carried out to investigate the effect of two differents namely; growth regulator, Furolan and mineral fertilizer on the following traits; quantity of productive stalks/plants m^{-2} and productive bushiness in three winter varieties namely Batko, Deya and Krasnodarskaya 99 at full ripeness phase. In the experimental variants of Bat'ko variety the quantity of plants m^{-2} varied from 288 pieces (control); 305 pieces (variant with only application of Furolan); 314 pieces (only fertilizers) to 318 pieces per m^{2} (the fertilized variant with fertilizers + growth regulator). Difference between control and other variants was statistically significant and recorded respectively as follows: 17; 9; 4 plants m^{-2} (LSD_{05}-variant = 2.70). In the interaction of factors AC Furolan enhanced bushiness in Bat'ko and Deya varieties. In both variants plant bushiness was 1.6. In Krasnodarskaya 99 variant the interaction of fertilizers and growth regulator bushiness seemed higher amounting to 1.7 (LSD_{05}- interaction AC = 0.07).

KEYWORDS: Wheat varieties; mineral fertilizer; Furolan; Quantity of Productive Stalks/Plants m^{-2} and Productive Bushiness; Full Ripeness Phase.

1.0 INTRODUCTION

1.0 Full ripeness phase

The grain filling period is critical for producing high yields because kernel size and weight are determined during this stage. Yields will be reduced by any stress (high temperatures, low soil moisture, nutrient deficiencies and diseases) occurring during grain fill. Environmental factors affect the rate and duration of the grain filling period (Richards et al., 1987; O'Toole and Stockle, 1991;) The longer this filling period lasts, the greater is the probability for higher yields (Palta, 1994). If this period is shortened, yields will usually be lower. In Kentucky, the average length of the grain filling period is one month. The grain fill period can be as few as 25 days or less in high stress environments (hot and dry weather, heavy disease and nutrient deficiencies) and may exceed 35 days in high yield, low stress environments (disease-free, high soil moisture, and moderate/cooler temperatures) (Herbek and Lee, 2009; Nicholas and Turner, 1993.).

During the ripening stage**;** Kernel moisture content is still high, usually ranging from 25 to 35 percent, when wheat begins to ripen but decreases rapidly with good weather. The plant turns to a straw color and the kernel becomes very hard (Acevedo, 1993; Acevedo et al., 1999). The kernel becomes difficult to divide with a thumbnail, cannot be crushed between fingernails and can no longer be dented by a thumbnail. Harvest can begin when the grain has reached a suitable moisture level (usually less than 20%) (Moustafa et al., 1996; Musick et al, 1994). Often harvest does not occur until grain moisture content is close to 15 percent, unless drying facilities are available (Leegood and Edwards, 1996; Kobata, et al., 1992). It is important for grain quality that the harvest begins as soon as possible. Test weight (and hence grain yield) may be reduced during the ripening process (Masle, J. 1984; Mian and Nafziger, 1994). Decreased test weight results from the alternate wetting (rains or heavy dews) and drying of the grain after the wheat has physiologically matured (Midmore et al., 1984; Richards, 1987 and Frank and Bauer, 1995).

At the full ripeness phase of the grain of winter wheat varieties the quantity of plants in cenosis are finally formed by number of productive stalks with ear m^{-2} which characterize yield (Gorham et al., 1987; Grieve et al., 1992; Hay and Kirby, 1991). From ear-formation phase to maturity the following traits are formed: number of productive stalks m^{-2}; quantity of plants with ear; length of ear/spike; plant height; number of cones ear^{-1}; number of generated grains per ear; full grains; grain weight spike^{-1} and plant^{-1}; 1000−grain weight and weight of agro-phytocenosis (Hay and Kirby, 1991; Jones and

Qualset, 1984). All these traits directly influence yield of variety. 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} and productive bushiness of three winter varieties at full ripeness phase.

2.0 MATERIALS AND METHODS

METHODOLOGY

This study was carried out between 2007– 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.

At the maturity phase of the wheat plant grains, some cases were observed where the grain quantity decreased (condition called cenosis) in experimental plots. This was not unconnected to the fact that the plants were subjected to frequent dry winds and inadequate rain leading to decrease in soil humidity, premature dying-off of leaves especially the upper ones thus hindering growth and photosynthetic processes during the maturity period of wheat plants in the Central zone of Krasnodar territory. Re-utilization of organic substances from leaves in the spike proceeded vigorously. After flowering and fertilization of egg-cells develops ovary, grain was formed according to development phases namely: milk, wax and full ripeness.

Under the high air temperature the grains lost moisture resulting in humidity of 13-14%. At this time harvesting commenced.

Prior to harvesting, quality sheaves of 20 plants were taken from each plot for biometric analysis. Thereafter, traits namely; quantity of productive stalks, quantity of plants m^{-2} and productive bushiness on which yield depended were respectively determined. The results 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}

Table 1: Data on the effect of different doses of mineral fertilizers and growth regulator on variation of plant quantity of winter wheat varieties at maturity 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	288		293		297		287
		Furolan	305					301	300
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	314	306	315		316		312
		Furolan	318					312	318
Deya	Control	control	281				289		
		Furolan	297					296	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	310	301			314		
		Furolan	317					307	
Krasnodar-skaya 99	Control	control	291				294		
		Furolan	297			299		301	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	311	305			315		
		Furolan	319			309		308	
LSD_{05}			2.70	**1.35**	**1.10**	**1.07**	**1.91**	**1.91**	**1.56**

Variation in plants of winter wheat varieties under the influence of mineral fertilizers and growth regulator, Furolan was investigated at maturity phase. In experimental variants of Bat'ko variety the quantity of plants m^{-2} varied from 288 pieces (control); 305 pieces (variant with only application of Furolan); 314 pieces (only mineral fertilizers) to 318 pieces per m^2 (variant with combined application of fertilizer + Furolan) (Table 1).

Difference between control and other variants was statistically significant and recorded respectively as follows: 17; 9; 4 plants m^{-2} (LSD_{05}-variant = 2.70).

For factor A (variety) the plants quantity m^{-2} on the average varied as follows: Bat'ko (306 pieces), Krasnodarskaya 99 (305 plants) and Deya (301 pieces). Among the varieties significant difference was established in plant quantity m^{-2} (LSD_{05}-factor A = 1.35). For factor B (mineral fertilizers) the plant quantity m^{-2} varied from 293 pieces (control) to 315 pieces (the fertilized variant). The difference between the fertilized variant and control on the average was 22 plants m^{-2} (LSD_{05}-factor B = 1.10).

For factor C (growth regulator) the plant quantity m^{-2} in the variants on the average varied from 299 pieces (untreated/control) to 309 plants (with application of growth regulator), (LSD_{05}-factor C = 1.07). According to studying results of interaction of factors B and C it was established that plant quantity m^{-2} on the average varied according to experimental variants: from 287 pieces (without fertilizers) to 300 pieces (treated with only Furolan). After treatment of plants in harvest output phase with Furolan they remained on the average; 13 pieces more than control (LSD_{05}-factor BC = 1.56). After applying only mineral fertilizers of $N_{50}P_{90}K_{40}$ + N_{60} in the spring + N_{30} dose in spike formation phase the quantity of plants on the average remained 312, but the combined interaction of mineral fertilizers and Furolan the quantity of plants remained 318 pieces m^{-2} (LSD_{05}- interaction factor BC = 1.56). All increases of the plant quantity per m^2 in experimental variants were significant.

By means of the three-factorial dispersion analysis the effects of different types of variation on plants at maturity were established. For example, the effect (influence) of the general variation on number of plants m^{-2} was 32.1%. The effect of experimental variants in on number of plants m^{-2} was 30.6%. The effect of factor A (variety) in the formation of plant (upright) density was 8.9%. At the maturity phase, the genotypes of varieties poorly regulated productive stalks. At this phase, this it could be deduced that all the plant biological processes were directed to the formation of reproductive organs and yield.

The effect of factor B (mineral fertilizers) on the formation of plant density was 23.6%. Fertilizer application and the last foliar dressing were carried out at the spike-formation phase with N_{30} kg added per hectare. This promoted conservation process of plant number per m^2. The effect of the factor C (growth regulator) on plant number before harvesting was weak at 4.7%.

Thus, all the biological processes were directed at the maturity phase of plants not only in their sustenance during fruiting, but also in the formation yield-building elements.

3.2. Quantity of productive stalks m^{-2}

Ripening of plants of winter wheat varieties is the final stage of the formation of productive stalks. The stalks have well developed spikes filled with grain; generating plant grain-yield. As a rule, productive stalks pre-harvest were always smaller than those of harvest output or spike-formation phase.

Under optimal ecological conditions of cultivation, varieties of winter wheat plants efficiently regulated quantity of stalks with spikes, capable of generating grain yield.

In the experimental variants of Bat'ko variety the quantity of productive stalks m^{-2} varied from 458 pieces (control - without fertilizers); 484 pieces (with growth regulator); 527 pieces (with mineral fertilizers) to 567 stalks (combined influence of fertilizers and Furolan). By application of only mineral fertilizers the number of productive stalks increased by 69 in comparison with control (Table. 2). Influence of only Furolan increased the quantity of productive stalks m^{-2} by 26 pieces in comparison with control. Combined effect of mineral fertilizers and Furolan on the productive stalks was 567pieces m^{-2} which was 109 stalks more than control (LSD_{05}-variant. = 14.54).

Table 2: Data on the variation of quantity of productive stalks of winter wheat varieties under the influence of various doses of fertilizers and growth regulator at the ripening 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	458		457		471		443
		Furolan	484					493	471
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	527	509	524		547		504
		Furolan	567					526	544
Deya	Control	control	415				438		
		Furolan	461					449	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	482	470			503		
		Furolan	523					492	
Krasnodar-skaya 99	Control	control	455				461		
		Furolan	467					479	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	503	492		473	523		
		Furolan	542			507		505	
LSD_{05}			14.54	**7.27**	**5.94**	**5.94**	**10.28**	**10.28**	**8.39**

A similar pattern was observed in other varieties. In this regard the consideration was not about increase in productive stalks m^{-2} by the different treatments. In this case, the sustenance and formation of productive stalks of winter wheat varieties was paramount.

In factor A (variety) the number of productive stalks varied: from 470 pieces (Deya); 492 pieces (Krasnodarskaya 99) to 509 pieces m^{-2} (Bat'ko). All these results were statistically significant (LSD_{05}-factor A = 7.27).

For factor B (mineral fertilizers) the quantity of productive stalks in experimental variants on the average varied from 457 pieces (control) to 524 stalks m^{-2} (the fertilized variants). The difference between these two variants was 67 stalks per m^2 (LSD_{05}-factor B = 5.94).

For factor C (growth regulator) the number of productive stalks m^{-2} varied from 473 pieces (without growth regulator) to 507 pieces (treatment with Furolan). Only the treated winter wheat plants at harvest output phase produced 34 plants m^{-2} more than control.

Interaction of mineral fertilizers and growth regulator showed statistically significant production of productive stalks by all experimental variants. In the control (without treatment) the number of productive stalks was on the average of 443 pieces m^{-2}. Combined interaction of mineral fertilizers and growth regulator led to production of 544 pieces m^{-2}. The difference between these variants was 101 stalk per m^2 (LSD_{05}- interaction BC = 8.39).

All differences in variants in the gradation system of experiments according to the quantity of productive stalks were statistically significant and indicated the reliability of mineral fertilizers and growth regulator application in the cultivation of winter wheat varieties for the seed production.

By means of the three-factorial dispersion analysis the effects (influence) of various types of variation in the formation productive stalks of winter wheat varieties were determined. The analysis showed that the effect of the general variation on the formation of the number of productive stalks m^{-2} was 32.6%. The effect of experimental variants on quantity of productive stalks was 31.5%. The effect of factor A (variety) on productive stalks was 9.7%. The effect of the factor B (mineral fertilizers) on the formation of productive stalks was substantial at 20.8%. The effect of factor C (growth regulator) on productive stalks was 5.3%. Here, one might consider the influence of Furolan not on the formation of stalks, as this was accomplished in spring bushing-out phase but on the effect on productive stalks, which positively influenced the final biological result – the grain yield.

3.3. Productive bushiness

In the ripening phase of grain of winter wheat varieties mention should be made not only about plant bushiness, but about production of stalks which formed full-scale spike for the production of future crop. The number of productive stalks per plant – is the potential yield value generated at this phase of development. There was notable decrease in bushiness of plants from the spike-formation to maturity phase. In this regard agro–ecological factors played a greater role than plant genotypes.

For the experimental variants of Bat'ko variety plant bushiness varied from 1.6 (control); 1.6 (only Furolan); 1.7 (mineral fertilizers) to 1.8 (mineral fertilizers plus growth regulator). The difference in bushiness between the extreme variants was 0.2 (LSD_{05}-variant = 0.10). Differences in bushiness were significant (Table 3).

In Deya and Krasnodarskaya 99 varieties the differences in bushiness among the variants were in the limits of LSD.

For factor A (variety) significant differences among the experimental variants were not established.

For the factor A (mineral fertilizers) variation of coefficients of bushing-out significantly differed in the experimental variants. In the control bushiness on the average was 1.6 stalks per plant, but in the fertilized variant it was 1.7 (LSD_{05}-factor B = 0.04). These differences were significant.

Table 3: Data on the variation of productive bushiness of winter wheat varieties under the influence of various doses of fertilizers and growth regulator at the ripening 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	1.6		1.6		1.6		1.6
		Furolan	1.6					1.7	1.6
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	1.7	1.7	1.7		1.8		1.6
		Furolan	1.8					1.7	1.7
Deya	Control	control	1.5				1.6		
		Furolan	1.6					1.6	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	1.6	1.6			1.6		
		Furolan	1.6					1.6	
Krasnodar-skaya 99	Control	control	1.6				1.6		
		Furolan	1.6					1.6	
	$N_{50}P_{90}K_{40}$ + N_{60} in the spring	control	1.6	1.6		1.6	1.7		
		Furolan	1.7			1.7		1.7	
LSD_{05}			0.10	**0.05**	**0.04**	**0.04**	**0.07**	**0.07**	**0.06**

For factor C (growth regulator) bushiness in the variants on the average varied from 1.6 to 1.7 (LSD_{05}-factor C = 0.04). The growth regulator, Furolan conserved the number of productive stalks per plant to maturity.

In the interaction of factors AC the growth regulator, Furolan influenced the conservation of bushiness in Bat'ko and Deya varieties. In both variants of these varieties plant bushiness was 1.6. Only in Krasnodarskaya 99 variant of interaction of mineral fertilizers and growth regulator bushiness appeared higher amounting to 1.7 (LSD_{05}- interaction AC = 0.07).

By means of the three-factorial dispersion analysis of trait of bushiness of winter wheat varieties the effect (influence) of different kinds of variation during the formation of plant bushiness was determined. The analysis showed that the effect of the general variation on the formation of additional stalks in plants was 36.7%. The effect of experimental variants during the formation of productive bushiness was 26.7%. The effect of the factor A (variety) during the formation bushiness amounted to 15.7%. This showed a strong effect of genotypes on productive bushiness. The effect of the factor B (doses of mineral fertilizers) during the formation of bushiness was 19.1%. Doses of mineral fertilizers made vital contribution during the conservation of productive stalks in winter wheat varieties. The effect of the factor C (growth regulator) in the conservation of bushiness was 1.7%. This effect of growth regulator, Furolan on productive stalks was weak.

4.0 CONCLUSION

The effect of the two differents namely; growth regulator, Furolan and mineral fertilizer investigated in this study on the following traits; quantity of productive stalks/plants m^{-2} and productive bushiness in three winter varieties namely Batko, Deya and Krasnodarskaya 99 at full ripeness phase was wide and varied. Generally, all the traits were significantly affected by the different treatments. For instance, in the experimental variants of Bat'ko variety plant bushiness varied from 1.6 (control); 1.6 (only Furolan); 1.7 (mineral fertilizers) to 1.8 (mineral fertilizers plus growth regulator). The difference in bushiness between the extreme variants was 0.2 (LSD_{05}-variant = 0.10). These differences in bushiness were significant.

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