Stability and technological value of common wheat varieties Enola, Illico and Ingenio treated with herbicide mixtures

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Abstract- The research was conducted during 2011 - 2013 in the experimental field of the Department of Plant Production in Agriculture Faculty at Trakia University. Stara Zagora. The field experiment was performed with three varieties of common wheat: Enola, Illico and Ingenio. The objective is to determine the influence of the imported herbicide formulations on the performance of common wheat and determination of the most valuable technological options regarding the stability of the yield. Variants of the experiment are as follows: 1. Control - no treatment with herbicides; 2. Axial one - 1000 ml.ha^{-1}; 3. Lintur + Traksos 150 g.ha^{-1} + 1200 ml.ha^{-1} - tank mixture; 4. Logran + Traksos 37.5 g.ha^{-1} + 1200 ml.ha^{-1} - tank mixture; 5. Lintur + Axial 150 g.ha^{-1} + 900 ml.ha^{-1} - tank mixture; 6. Logran + Axial 37.5 g.ha^{-1} + 900 ml.ha^{-1} - tank mixture; 7. Lintur + Axial 150 g.ha^{-1} + 600 ml.ha^{-1} - separate treatment;8. Lintur + Traksos 150 g.ha^{-1} + 1200 ml.ha^{-1} - separate treatment; 9. Logran + Axial 37.5 g.ha^{-1} + 600 ml.ha^{-1} - separate treatment.10. Logran + Traksos 37.5 g.ha^{-1} + 1200 ml.ha^{-1} - separate treatment. Synthesis criterion for stability YSi by Kang taking into account both the stability and value of production, shows that in terms of technology growing, technologically the most valuable is the variant of decoupling Lintur + Axial (10+). Axial one herbicide was highly complex assessment (11+) for technological stability of yields. In varieties Illico and Ingenio most technologically valuable options appear involving herbicide Axial one (12+) and separately imported Lintur + Axial (5+).

Index Terms- common wheat, herbicides, grain yield, stability

I. INTRODUCTION

Wheat is the major cereal crop in the world. Our country, although small territory is characterized by large variations in the voltage of the meteorological elements in different regions. To obtain stable yields necessary introduction of new varieties of high-and determine the most appropriate structure of varieties for each region and subregion of the country. Productive potential of wheat depends on the tolerance of varieties to abiotic stress. Proper varietal structure depending on the specific agro-ecological conditions of the region can significantly increase the yield and quality of production [1-2]. Structural elements of production are influenced largely by the conditions of the year plasticity of variety[3-4] .

Several studies have examined the influence of individual factors to agriculture complex. Tillage, weeding levels and types, climatic conditions, the sowing and sowing rate, balanced fertilization create conditions for well trimmed and competitive crops against weeds [5-11].

The application of herbicides in wheat is one of the most important moments in her agrotechnics [11- 18]. Weeds are a major limiting factor for grain production in the world and in our country. Successful and effective fight against them in wheat can be relied upon after a detailed and comprehensive survey of the areas and predicting species diversity of weed background.

The aim of this study was to investigate the influence of imported herbicides and herbicide mixtures on productivity of three varieties of common wheat and identification of the most valuable technological options regarding the stability of yields.

II. MATERIALS AND METHODS

Field experimental study was conducted in the experimental field of the Department of Crop, Faculty of Agriculture, Trakia University. In the period 2011-2013 was set experience with three varieties of common wheat - Enola, Illico and Ingenio. The soil type in the experimental field is characterized by typical meadow cinnamonnnic soil. The power of the humus horizon in this soil type varies widely from 30 cm to 75 cm. Meadow cinnamonnnic soil is characterized by slightly acidic soil solution. Climatically, the area of the field study falls within the climatic region of Central and Eastern Bulgaria, European continental climatic region and continental sub it. The main agro-meteorological indicators that characterize the relatively best climatic conditions in the vegetation of wheat are the average diurnal temperature (and especially during ear formation-maturation phases) and the balance of atmospheric humidity.

Examined the following factors: factor A - three varieties of common wheat: Enola - Bulgarian and Illico and Ingenio of Syngenta; factor B - Herbicide: Axial one (pinoxaden + florasulam) - 1000; Axial 050 EC (pinoxaden) - 900 ml.ha^{-1}; Traksos 045 EC (pinoxaden + clodinafop) - 1200 ml.ha^{-1}; Logran 20 WG (triasulfuron) – 37.5 g.ha^{-1}; Lintur 70 WG (triasulfuron + dicamba) - 150 g.ha^{-1}. The active ingredients of the herbicides are shown in Figures 1-5.

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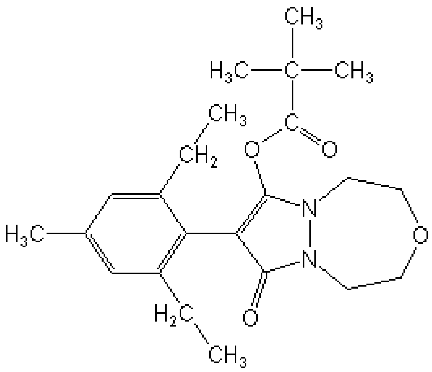

Figure 1. The structural formula of Pinoxaden

IUPAC: 8-(2,6-diethyl-*p*-tolyl)-1,2,4,5-tetrahydro-7-oxo-7*H*-pyrazolo[1,2-*d*][1,4,5]oxadiazepin-9-yl 2,2-dimethylpropionate

Formula: $C_{23}H_{32}N_2O_4$

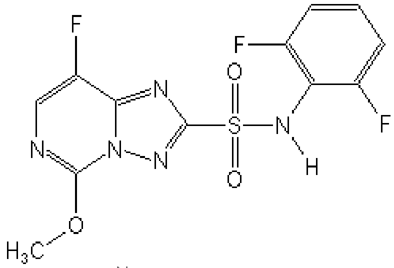

Figure 2. The structural formula of Florasulam

IUPAC: 2′,6′,8-trifluoro-5-methoxy[1,2,4]triazolo[1,5-*c*] pyrimidine-2-sulfonanilide

Formula: $C_{12}H_8F_3N_5O_3S$

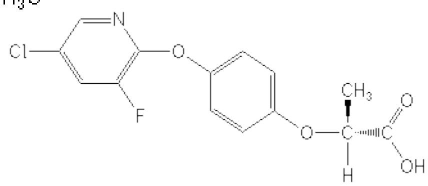

Figure 3. The structural formula of Clodinafop

IUPAC: (*R*)-2-[4-(5-chloro-3-fluoro-2-pyridyloxy) phenoxy]propionic acid

Formula: $C_{14}H_{11}ClFNO_4$

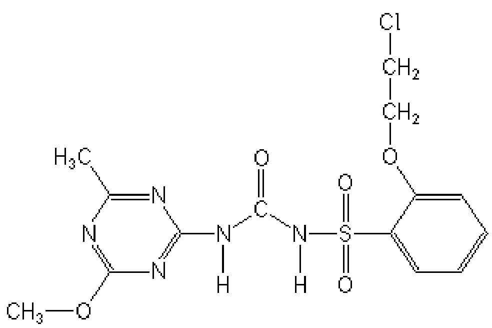

Figure 4. The structural formula of Triasulfuron

IUPAC: 1-[2-(2-chloroethoxy)phenylsulfonyl]-3-(4-methoxy-6-methyl-1,3,5-triazin-2-yl)urea

Formula: $C_{14}H_{16}ClN_5O_5S$

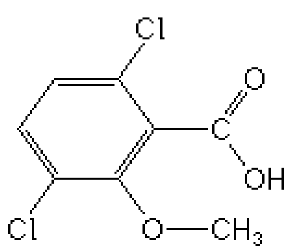

Figure 5. The structural formula of Dikamba

IUPAC: 3,6-dichloro-*o*-anisic acid or 3,6-dichloro-2-methoxybenzoic acid

Formula: $C_8H_6Cl_2O_3$

Variants of the experience are:

1. Control - no treatment with herbicides;
2. Axial one - 1000 $ml.ha^{-1}$;
3. Lintur + Traksos 150 $g.ha^{-1}$ + 1200 $ml.ha^{-1}$ - tank mixture;
4. Logran + Traksos 37.5 $g.ha^{-1}$ + 1200 $ml.ha^{-1}$ - tank mixture;
5. Lintur + Axial 150 $g.ha^{-1}$ + 900 $ml.ha^{-1}$ - tank mixture;
6. Logran + Axial 37.5 $g.ha^{-1}$ + 900 $ml.ha^{-1}$ - tank mixture;
7. Lintur + Axial 150 $g.ha^{-1}$ + 600 $ml.ha^{-1}$ - separate treatment;
8. Lintur + Traksos 150 $g.ha^{-1}$ + 1200 $ml.ha^{-1}$ - separate treatment;
9. Logran + Axial 37.5 $g.ha^{-1}$ + 600 $ml.ha^{-1}$ - separate treatment.

10. Logran + Traksos 37.5 g.ha^{-1} + 1200 ml.ha^{-1} - separate treatment;

Introduction of a reservoir mix means that the solution of plant protection chemicals is prepared together, i. e. the herbicides dissolved in a container and the treatment is carried out simultaneously. In separate treatment first herbicide is paid-in Logran and Lintur after a week was treated with other preparation (Traksos and Axial), as set out in the methodology.

III. RESULTS AND DISCUSSION

Important role in the cultivation of common wheat held conducting timely weed control, which are competitors of crops. Perennial broadleaf weeds in experience are represented by thistle, convolvulus, oak, milkweed. Annual broadleaf weeds are represented by Arthemis arvensis, Matricaria spp., Sinapis arvensis, Raphanus raphanistrum, Capsella bursa-pastoris, Myagrumperfoliatum, Polygonum convolvulus, Stellaria media, Papaver rhoeas, Viola arvensis, Veronica hederifolia, Lamium purpureum. Cereal weeds met Avena fatua, Alopercurus myosurides, Lolium sp., Bromus arvensis. Treatment of weeds was held in methodology in the phase of stem of wheat.

Yields are the result of the influence of the year (complex climatic factors) and efficiency of the studied herbicides. In the second year of the field experience recorded higher yields. Herbicide mixture Traksos with Lintur provides high yields in both years, respectively 3180.1 kg.ha^{-1} and 7569.9 kg.ha^{-1} in Enola (Table. 1). Highest positive impact of imported products is noted in spray tank mixture Logran + Traksos in the second experimental year (167.1%) and the average for the period of study was 152.2%. In Illico treatment Axial one results in 41.1% yield increase compared to untreated control.

Table I: Effect of some herbicidal mixtures on grain yield of variety Enola (average 2011/12 – 2012/13)

Variants	**2012**		**2013**		**Average**	
	kg.ha^{-1}	**%**	**kg.ha^{-1}**	**%**	**kg.ha^{-1}**	**%**
1. Control - no treatment with herbicides	2281.1	100.0	5231.5	100	3756.3	100.0
2. Axial one -1000 ml.ha^{-1}	2822.9	123.8	6618.2	126.5	4720.6	125.7
Tank mixture						
3. Lintur + Traksos 150 g.ha^{-1} + 1200 ml.ha^{-1}	3180.8	139.4	7569.9	144.7	5375.4	143.1
4. Logran + Traksos 37.5 g.ha^{-1} + 1200 ml.ha^{-1}	2689.2	117.9	8741.4	167.1	5715.3	152.2
5.Lintur + Axial 150 g.ha^{-1} + 900 ml.ha^{-1}	3138.4	137.7	6188.6	118.3	4663.5	124.2
6. Logran + Axial 37.5 g.ha^{-1} + 900 ml.ha^{-1}	2549.0	111.7	6724.7	128.5	4638.9	123.5
Separate treatment						
7. Lintur + Axial 150 g.ha^{-1} + 600 ml.ha^{-1}	3281.6	143.9	5769.0	110.3	4525.3	120.5
8. Lintur + Traksos 150 g.ha^{-1} + 1200 ml.ha^{-}	2921.8	128.1	5536.0	105.8	4228.9	112.6
9. Logran + Axial 37.5 g.ha^{-1} + 600 ml.ha^{-1}	2708.3	118.7	6685.2	127.8	4696.8	125.0
10. Logran + Traksos 37.5 g.ha^{-1} + 1200 ml.ha^{-1}	2561.0	112.3	5914.7	113.1	4237.9	112.8

High results were obtained under the influence of the separate introduction of herbicides Axial + Lintur and Axial + Logran - 177.7% compared to the untreated control in the first year. Decoupling of the crop with Axial + Lintur average for the entire period contributed to obtain the highest yields - 128.2% (Table. 2).

The analysis of the results obtained in studying the influence of some herbicide combinations on grain yield of variety Inzhenio show that the introduction of Axial + Lintur (separately) and Axial one contribute to obtain higher scores respectively 121.1% and 117.8% (Table. 3).

The analysis of variance for the harvesting of grain found that the influence of variations in the test is 92.0% Enola of the total variance of the data shown in the differences $r \leq 0,1\%$ (Table. 4). Years have the strongest influence on grain yield - 75.4%. It is conditioned by the unequal response options to changes in environmental conditions. The reason for the large differences in weather conditions during the years of the study. The strength of the effect of the herbicides was 10.4%. The influence of the two factors of experience - years and herbicides is

Table II: Effect of some herbicidal mixtures on grain yield of variety Illico

Variants	2012		2013		Average	
	kg.ha^{-1}	%	kg.ha^{-1}	%	kg.ha^{-1}	%
1. Control - no treatment with herbicides	3033.3	100.0	7110.7	100.0	5072.0	100.0
2. Axial one -1000 ml.ha^{-1}	4280.3	141.1	7744.5	108.9	6012.4	1118.5
Tank mixture						
3. Lintur + Traksos 150 g.ha^{-1} + 1200 ml.ha^{-1}	4766.7	157.1	7912.1	111.3	6339.4	125.0
4. Logran + Traksos 37.5 g.ha^{-1} + 1200 ml.ha^{-1}	4922.3	162.3	7475.0	105.1	6198.7	122.2
5.Lintur + Axial 150 g.ha^{-1} + 900 ml.ha^{-1}	4500.0	148.4	7521.2	105.8	6010.6	118.5
6. Logran + Axial 37.5 g.ha^{-1} + 900 ml.ha^{-1}	4430.6	146.1	7573.7	106.5	6002.2	118.3
Separate treatment						
7. Lintur + Axial 150 g.ha^{-1} + 600 ml.ha^{-1}	4983.3	164.3	7157.7	100.7	6070.5	119.7
8. Lintur + Traksos 150 g.ha^{-1} + 1200 ml.ha^{-}	4779.4	157.6	7248.4	101.9	6013.9	118.6
9. Logran + Axial 37.5 g.ha^{-1} + 600 ml.ha^{-1}	5391.2	177.7	7610.5	107.0	6500.9	128.2
10. Logran + Traksos 37.5 g.ha^{-1} + 1200 ml.ha^{-1}	5391.2	177.7	7243.7	101.9	6317.5	124.6

Table III: Effect of some herbicidal mixtures on grain yield of variety Ingenio (average 2011/12 – 2012/13)

Variants	2012		2013		Average	
	kg.ha^{-1}	%	kg.ha^{-1}	%	kg.ha^{-1}	%
1. Control - no treatment with herbicides	3179.3	100.0	7450.0	100.0	5314.7	100.0
2. Axial one -1000 ml.ha^{-1}	3803.2	119.6	8718.5	117.0	6260.3	117.8
Tank mixture						
3. Lintur + Traksos 150 g.ha^{-1} + 1200 ml.ha^{-1}	3174.7	99.8	8782.2	117.9	5978.5	112.5
4. Logran + Traksos 37.5 g.ha^{-1} + 1200 ml.ha^{-1}	3124.3	98.3	8866.1	119.0	5995.2	112.8
5.Lintur + Axial 150 g.ha^{-1} + 900 ml.ha^{-1}	3674.7	115.6	8283.5	111.2	5979.1	112.5
6. Logran + Axial 37.5 g.ha^{-1} + 900 ml.ha^{-1}	3193.5	100.4	8119.2	109.0	5656.4	106.4
Separate treatment						
7. Lintur + Axial 150 g.ha^{-1} + 600 ml.ha^{-1}	2680.4	84.3	8502.1	114.1	5591.3	105.2
8. Lintur + Traksos 150 g.ha^{-1} + 1200 ml.ha^{-}	3557.1	111.9	7939.5	106.6	5748.3	108.2
9. Logran + Axial 37.5 g.ha^{-1} + 600 ml.ha^{-1}	4550.0	143.1	8326.1	111.8	6438.1	121.1
10. Logran + Traksos 37.5 g.ha^{-1} + 1200 ml.ha^{-1}	3374.3	106.1	8210.5	110.2	5792.4	109.0

very well demonstrated in $r \leq 0.1\%$. There is an interaction of the herbicide with the terms of years (A x B) - 6.2 %. It has been shown in differences $r \leq 5\%$.

Table IV: Analysis of variance for common wheat variety Enola

Source of variation	Degrees of freedom	Sum of squares	Influence of factor, %	Mean squares
Total	89	2442	100	-
Tract of land	2	1408	5.7	6.5**
Variants	29	2462	92.0	77872.6***
Factor A - Years	2	2036	75.4	941567.9***
Factor B - herbicides	9	2546	10.4	26163.7***
A x B	18	1510	6.2	7761.0***
Pooled error	58	6272	2.3	106.1

In Iliko the factor of the year is 79.6%, while the impact of herbicides was 9.0% at $r \leq 0,1$ warranted (Table. 5).

Table V: Analysis of variance for common wheat variety Illico

Source of variation	Degrees of freedom	Sum of squares	Influence of factor, %	Mean squares
Total	89	1378	100	-
Tract of land	2	18176	8.5	9088.0***
Variants	29	1388	90.0	4752031.0***
Factor A - Years	2	1192	79.6	55604.7***
Factor B - herbicides	9	1243	9.0	1287.9***
A x B	18	60999968	1.4	315.9***
Pooled error	58	62208	1.5	1072.6

The reason for the large differences in weather conditions during the two years of the study. Complex influence factors was only 1.4% in proven $r \leq 0,1$. Analysis of variance in Indzhenio found that the influence of test options is 97.2% of the total variance of the data shown in differences $r \leq 0,1\%$. The influence of the years most 93.3% (Table. 6).

Table VI: Analysis of variance for common wheat variety Ingenio

Source of variation	Degrees of freedom	Sum of squares	Influence of factor, %	Mean squares
Total	89	3731	100	-
Tract of land	2	2304	1.5	1152.0
Variants	29	3730	97.2	5875.7***
Factor A - Years	2	3581	93.3	81805.9***
Factor B - herbicides	9	8723712	2.3	442.8***
A x B	18	61283384	1.6	155.5***
Pooled error	58	126976	1.3	2189.2

It is conditioned by the unequal response options to changes in environmental conditions. The strength of the effect of the herbicides was 2.3%. The influence of the two factors of experience - years and herbicides is very well demonstrated in $r \leq 0.1\%$. There is an interaction of the herbicide with the terms of years (A x B) - 1.6%.

Table VII: Stability parameters in some herbicide combinations for common wheat variety Enola with relation to years

Variants	$\bar{x}$	σ_i^2	S_i^2	W_i	YS_i
1. Control - no treatment with herbicides	3757.3	429211.3**	-131.3	853154.9	-10
2. Axial one -1000 ml.ha^{-1}	4720.5	-96159.3	7.9	12562.0	11+
Tank mixture					

3. Lintur + Traksos 150 $g.ha^{-1}$ + 1200 $ml.ha^{-1}$	5375.3	335750.8**	87.9	703618.1	4+
4. Logran + Traksos 37.5 $g.ha^{-1}$ + 1200 $ml.ha^{-1}$	5715.3	5062001**	383.8	8265618.0	5+
5.Lintur + Axial 150 $g.ha^{-1}$ + 900 $ml.ha^{-1}$	4661.8	297506.3**	-8.3	642428.8	1+
6. Logran + Axial 37.5 $g.ha^{-1}$ + 900 $ml.ha^{-1}$	4636.9	104262.0**	55.9	333236.0	-5
Separate treatment					
7. Lintur + Axial 150 $g.ha^{-1}$ + 600 $ml.ha^{-1}$	4525.3	1284858**	-137.0	2222190.0	-7
8. Lintur + Traksos 150 $g.ha^{-1}$ + 1200 $ml.ha^{-}$	4228.9	1010566**	-127.6	1783323.0	-8
9. Logran + Axial 37.5 $g.ha^{-1}$ + 600 $ml.ha^{-1}$	4696.8	-34326.7	27.6	111494.1	10+
10. Logran + Traksos 37.5 $g.ha^{-1}$ + 1200 $ml.ha^{-1}$	4236.5	-72828.0	19657.0**	49892.1	-1

The parameters for determining the technological value and stability of the embodiments are presented in tables 7, 8 and 9. On the basis of the demonstrated interactions between factors year and herbicide combination, was assessed the stability of the occurrence of each of the options. Variance are calculated stability σi^2 and Si^2 by Shukla, Wi ecovalence in Wricke and stability criterion of YSi by Kang. Variance stability (σi^2 and Si^2) by Shukla, who reported linear and nonlinear interactions unidirectional assess the stability of the options. These variants, which show low values are considered to be more stable, because they interfere less with the environmental conditions. In ecovalence by Wricke, the higher are the values of the index, the more unstable is the version.

In Enola variance σi^2 stability and Si^2 by Shukla and ecovalence by Wricke show that highly stable variants is tank mixed with Traksos + Logran. The first three parameters indicate any tank mix as a highly stable. Synthesis criterion for stability of YSi by Kang, taking into account both the stability and value of production, gave a negative assessment of the reservoir mixture Logran + Axial (-5) and praised the separate treatment Lintur + Axial (10+). Herbicide Axial one also gets high complex assessment (11 +) for technological stability of yields. According Synthesis criterion for stability of YSi by Kang, in the buttonhole, most technologically valuable options appear with the participation of herbicides Lintur + Traksos (tank mixture) - 5+ and Axial + Lintur (separate treatment) - 4+.

Variance are calculated stability σi^2 and Si^2 by Shukla, Wi ecovalense in Wricke and stability criterion of YSi by Kang. According to the first parameter most stable options appear with the lowest values. Of the attached table 9 can see that variants involving preparation Axial one tank mixtures Logran + Axial and Lintur + Traksos and separate treatment of Lintur + Traksos feature lows. This makes these embodiments stable. The most unstable outlines options by applying a tank mixture Logran + Traksos. Indicator of YSi by Kang technologically most valuable is the herbicide Axial one (12 +).

Table VIII: Stability parameters in some herbicide combinations for common wheat variety Illico with relation to years

Variants		σ_i^2	S_i^2	W_i	YS_i
1. Control - no treatment with herbicides	5072.0	1439957**	0.5	2371695.0	-10
2. Axial one -1000 $ml.ha^{-1}$	6012.3	346860.7**	0.2	622741.1	-6
Tank mixture					
3. Lintur + Traksos 150 $g.ha^{-1}$ + 1200 $ml.ha^{-1}$	6339.4	57177.1**	-0.2	159247.5	4+
4. Logran + Traksos 37.5 $g.ha^{-1}$ + 1200 $ml.ha^{-1}$	6198.7	24616.4**	0.1	107180.3	2+
5.Lintur + Axial 150 $g.ha^{-1}$ + 900 $ml.ha^{-1}$	6007.3	-4378.2	20.6	60757.3	1+
6. Logran + Axial 37.5 $g.ha^{-1}$ + 900 $ml.ha^{-1}$	6002.2	55534.8**	0.3	156619.8	-9
Separate treatment					
7. Lintur + Axial 150 $g.ha^{-1}$ + 600 $ml.ha^{-1}$	6070.5	348360.5**	-4.6	625140.9	1+

8. Lintur + Traksos 150 g.ha^{-1} + 1200 ml.ha^{-}	6013.9	73129.0**	1.6	184770.4	-5
9. Logran + Axial 37.5 g.ha^{-1} + 600 ml.ha^{-1}	6540.9	211801.8**	6.4	406646.9	5+
10. Logran + Traksos 37.5 g.ha^{-1} + 1200 ml.ha^{-1}	6317.4	835148.3**	-0.2	1403998.0	3+

Table IX: Stability parameters in some herbicide combinations for common wheat variety Ingenio with relation to years

Variants		σ_i^2	S_i^2	W_i	YS_i
1. Control - no treatment with herbicides	5314.7	31.3**	2.0	569035.6	-10
2. Axial one -1000 ml.ha^{-1}	6260.8	-41789.4	1.2	1233.9	12+
Tank mixture					
3. Lintur + Traksos 150 g.ha^{-1} + 1200 ml.ha^{-1}	5978.5	4444629**	1.2	779503.3	1+
4. Logran + Traksos 37.5 g.ha^{-1} + 1200 ml.ha^{-1}	5995.2	643063.9**	7.8	1096999.0	3+
5.Lintur + Axial 150 g.ha^{-1} + 900 ml.ha^{-1}	5989.1	40592.4**	3.0	133044.8	2+
6. Logran + Axial 37.5 g.ha^{-1} + 900 ml.ha^{-1}	5656.3	-41128.7	1.2	2290.9	1+
Separate treatment					
7. Lintur + Axial 150 g.ha^{-1} + 600 ml.ha^{-1}	5591.3	777165.8**	1.1	1311562.0	-9
8. Lintur + Traksos 150 g.ha^{-1} + 1200 ml.ha^{-}	5748.3	195787.1**	2.6	381356.3	-7
9. Logran + Axial 37.5 g.ha^{-1} + 600 ml.ha^{-1}	6438.1	1113616**	2.4	1849882.0	5+
10. Logran + Traksos 37.5 g.ha^{-1} + 1200 ml.ha^{-1}	5792.4	-40177.3	1.6	3813.2	2+

IV. CONCLUSIONS

As a result of the field study found that treatment with tank mixtures of Logran + Traksos and Lintur + Traksos provide higher yields - in Enola 52.2% and 43.1%, in Illico 22.2% and 25.0% and Ingenio and 12.5 - 12.8% when compared with the untreated control. The data show that good results are obtained and introduction of a herbicide Axial one respectively 17.8%, 18.5% and 25.7%.

Synthesis criterion for stability of YSi by Kang, taking into account both the stability and value of production, gave a negative assessment of the reservoir mixture Logran + Axial (-5) and praised the decoupling Lintur + Axial. Herbicide Axial one was highly complex assessment for technological stability of yields.

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