Research Result Report of ESBIOFUL (*Pseudomonas fluorescens*) Commercial Preparation on Activity of Bread Wheat

Organization Condacting the Research

Gap International Agricultural Research and Education Center /Diyarbakir

Purpose: To determine the effect of microbial fertilizer called ESBIOFUL with PGPR *Pseudomonas fluorescens* on grain yield, yield parameters, effect of grain in some macro and micro nutrients content, and some element quantities of soil in bread wheat.

Introduction: Soil contains a large number of microorganism communities. Bacteria that are associated with plant roots among these microorganism communities are called root bacteria. Considering the interaction of these root bacteria with plant roots, it is seen that some of them are beneficial and some of them have harmful effects. Some of the beneficial effects of the root bacteria in plants, such as stimulating the development or acting as a biocontral agent or by acting in both ways are beneficial to plants (Romerio, 2000). Root bacteria (Plant Growth Promoting Rhizobacteria: PGPR), which stimulate plant growth, are used for this beneficial effect.

It is known that PGPR bacteria are effective on plant growth by making the nutrients necessary for the plant to turn into useful forms. *Pseudomonas fluorescens* in the plant growth-inducing root bacteria (PGPR) group are known to contribute to the increase in yield in plant groups with vegetables and other economic value by establishing contact with plant roots. It is known that PGPR bacteria are effective on plant growth by making nutrients necessary for plant in soil to be transformed into useful form. It is known that they contribute to increase yield in vegetables and other economically important plant groups by establishing a relationship with *Pseudomonas fluorescens* plant roots in the group of Root bacteria (PGPR) that stimulates plant growth.

Material and Method

The study was conducted during the 2014-2015 wheat growing season in the trial area of the GAP International Agricultural Research and Training Center Directorate and in the conditions of precipitation. The experimental site soils are clayey-loamy, medium salty (0.400%), less organic matter (1.66%), strong alkaline (pH: 8.07%), lime medium (7.93%) and phosphorus (3.38 kg/da) level favorable available by plant is low.

As a material in study were used the water-based microbial "ESBIOFUL" fertilizer containing 108 KOB/G *Pseudomonas fluorescens* bacteria prepared and transported by **BAGBANLAR Fertilizer and Agricultural Products San.Ltd Sti,** and DİNC bread wheat variety developed by GAP International Agricultural Research and Education Center. **In the experiment,** 4 different applications were performed: **control, inoculated seed** (2 L Esbioful / 1 ton seed), **foliar application** (150 ml Esbioful / decare) and **inoculated seed + foliar application**. In suspension prepared from the biological preparation Esbioful (1/100), the seeds of wheat were kept for 30 minutes and were vaccinated. Foliar application of wheat plants in the period of bolting falling 30 L water to per decare in the form of 150 ml Esbioful fertilizer was taken with back pulverizatior. No application was applied to the control parcels.

The experiment was carried out with 4 replications in the Randomized Block Design. In the trials, the parcel areas (12 m x 1.2 m) were adjusted to be 14.4 m^2. The plantings were made on 20 November 2014 with 450 seeds per square meter. In the study, number of anther days, number of days of ripening, plant height, number of anther per square meter, anther length, number of anther, number of grain in anther, grain weight per anther, biological yield, grain yield, harvest index, hectoliter, protein ratio, sedimentation and moisture gluten parameters were investigated. The data obtained from the study were subjected to variance analysis in JMP 5.1 statistical package program and the differences between means were compared with LSD (0.0.5) multiple comparison test.

Research results:

PGPR *Pseudomonas fluorescens* containing ESBOFUL, four different application of microbial fertilizer in wheat, number of days of anther, number of days of ripening, plant height, number of anther per square meter, anther length, number of anthers in anther, grain number per anther, grain weight per anther, biological yield, grain yield, harvest index, hectoliter weight, protein content, sedimentation and moisture gluten characteristics are given in Tables 1 and 2.

As can be seen in Table 1 and 2, the effect of ESBOFUL applications on wheat anthering days, plant height, number of anthers per square meter, number of seeds per anther meter and decare grain yield was statistically significant at 0.05 level and the effect on other investigated properties was statistically insignificant. The number of anther days ranged from 114.7 to 117.2, and seed vaccination + foliar application methods were found to have the earliest anther days and were included in the same group. Plant

height was determined as 96.2 - 100.7 cm and the highest plant height was determined by seed vaccination + foliar application method.

The number of anther per square meter was 602.5 - 635.0 and the number of grain per anther was changed between 53.0 and 63.5 units. The highest values were obtained from foliar application method while the lowest values were obtained from control application. However, seed vaccination + foliar application method by the method of foliar application were statistically included in the same group.

Table 1. ESBİOFUL applications in wheat number of anthering days, number of days of ripening, plant height, number of anthers per square meter, anther length, number of spikelets in anther, number of grain in anther and the effect of grain weight on anther.

Applications	Number of anthering days (day)	Number of days of ripening (day)	Plant height (cm)	Number of anthers per square meter (pcs)	Anther length (cm)	Number of spikelets in anther (pcs)	Number of grain in anther (pcs)	Grain weight of anther (g)
T1 (Control)	2255.2	779.3 b	42.03	35.31	84.85	10.7	23.5	21.9
T2 (2l/1ton seed vaccination)	2022.9	814.9 ab	43.81	36.44	84.78	10.9	24.8	22.2
T3(Foliar application)	2116.7	820.3 a	43.87	36.13	84.75	11.0	25.8	22.5
T4(seed vaccination+foliar application)	1990.6	838.2 a	44.22	35.81	84.63	11.1	26.5	22.7
Average	**2096.4**	**813.2**	**43.48**	**35.92**	**84.75**	**10.9**	**25.1**	**22.3**
CV (%)	**11.21**	**2.84**	**4.55**	**4.04**	**0.34**	**9.44**	**30.72**	**10.28**
LSD	**NS**	**36.90**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

and respectively significant at P<0.05 and P<0.01 level: NS: not significant

The difference between the averages indicated in the same letters is not significant at P <0.05.

The Effect of Different ESBIOFUL Applications on Some Macro and Micro Element Contents in Wheat:

The results of the analysis of some macro and micro elements (Al, Ca, Cr, Cu, Fe, K, Mg, Mn, P, Se, and Zn) in wheat grain are given in Table 3.

Table 3. Effect of ESBIOFUL applications on some macro and micro elements in wheat grain (Al, Ca, Cr, Cu, Fe, K, Mg, Mn, P, Se and Zn) content.

Applications	Al	Ca	Cr	Cu	Fe	K	Mg	Mn	P	Se	Zn
Tl (Control)	11.47 b	120.63	0.432	2.49	29.42	2599.88 a	847.9 ab	40.53	389.30	0.725	12.64 a
T2 (1 L/1 ton seed vaccination)	20.24 ab	118.35	0.383	2.97	30.28	2508.65 b	863.4 ab	35.58	405.39	0.468	10.86 b
T3 (Foliar application)	22.80 a	111.90	0.417	2.63	29.01	2604.10 a	811.8 b	35.50	361.79	0.683	11.80 b
T4 (Seed vaccination + foliar application)	24.29 a	121.84	0.323	2.63	30.03	2514.55 ab	918.7 a	35.42	402.98	0.605	13.40 a
DK %	**14.04**	**12.5**	**13.52**	**8.89**	**6.81**	**1.39**	**4.01**	**7.23**	**5.26**	**13.92**	**6.14**

and respectively significant at P<0.05 and P<0.01 level: NS: not significant

The difference between the averages indicated in the same letters is not significant at P <0.05.

LSD	**9.67***	**NS**	**NS**	**NS**	**NS**	**90.83***	**66.65***	**NS**	**NS**	**NS**	**1.83***

When Table 3 is analyzed, it is seen that the effect of ESBIOFUL applications on wheat, Al, K, Mg and Zn content is statistically significant at 0.05 level and while the highest values for Al, Mg and Zn content are obtained from seed vaccination + foliar application method, the highest value in terms of K content was obtained only from foliar application method. As a result of the study, there was no statistically significant difference between the other elements examined (Ca, Cr, Cu, Fe, Mn, P and Se).

The Effect of Different ESBIOFUL Applications on Some Elemental Quantities in Soil:

Applications	**Organic matter (%)**	**Total Nitrogen (N) (%)**	**Receivable Phospor (P) (kg/da)**	**Receivable Potassium (K) (kg/da)**	**Receivable Calcium (Ca) (kg/da)**	**Receivable Magnesium (Mg) (ppm)**	**Receivable Iron (Fe) (ppm)**	**Receivable Mangan (ppm)**	**Receivable Zinc (Zn) (ppm)**	**Receivable Copperr (Cu) (ppm)**

The results of four different applications of ESBIOFUL microbial fertilizer in wheat are given in Table 4. When Table 4 is analyzed, ESBIOFUL applications have an increase effect on the amount of organic matter, total nitrogen (N), Phosphorus (P), Iron (Fe), Zinc (Zn) and Copper (Cu) element in the soil. While 1 L / 1 tone seed vaccination application was emphasized in terms of organic matter and total nitrogen (N) ratio in the soil, foliar application method has become prominent in terms of Fe, Zn and Cu values. The highest values in the maintenance of Phosphorus (P) value in soil can be obtained from both methods (seed vaccination + foliar application).

Table 4. Effect of ESBIOFUL microbial fertilizer applied on wheat in organic matter ratio and some element amounts of soil.

Tl (Control)	2.21	0.11	0.74	176.81	9400.00	648.80	4.70	10.81	1.35	2.16
T2 (1 L/1 ton seed vaccination)	2.73	0.14	0.86	156.39	9035.00	616.60	7.30	9.82	1.36	2.42
T3 (Foliar application)	2.38	0.12	0.97	163.16	9349.00	627.30	7.44	10.39	1.43	2.49
T4 (Seed vaccination + Foliar application)	2.67	0.13	1.09	169.67	9258.00	621.80	6.96	7.39	1.41	2.33

Result: With the results of the research conducted and the results given above, was determined that the different application methods of ESBIOFUL (*Pseudomonas fluorescens*) commercial preparation in wheat anther number, plant height, number of anther per square meter, number of pieces in anther, and grain yield per decare: the effect of ESBIOFUL on anther length, number of spikelets in anther, number of grain in anther, 1000 grain weight from quality parameters with grain number per anther, hectoliter weight, sedimentation, wet gluten and protein ratio was found to be positive but this effect was statistically insignificant.

In this study, seed vaccination + foliar ESBIOFUL application method giving the highest grain yield provided a higher yield increase of 7.6%, compared to the control method in which the preparation was not applied. In the study, ESBIOFUL application method in wheat yielded a higher yield increase by 7.6% compared to the control method in which the preparation was not applied. In this study, the effect of ESBIOFUL application on grain Al, K, Mg and Zn content and seed vaccination + foliar application method to care of Al, mg and Zn contents, and the method of application of leaf in K content maintenance has been

taken precedence. It is also seen that organic matter in the soil, with the total N ratio, increased the content of P, Fe and Cu by applying seeds of ESBIOFUL microbial fertilizer with the seed vaccination and foliar application. (21. 08.2015).

Best regards,

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Table 3. The average of meteorological parameters of Diyarbakir province for the wheat growing season of 2014-2015.

Months	Max. Temperature (^{0}C)	Min. Temperature (^{0}C)	Average Temperature (^{0}C)	Cloudiness day number (day)	Average moisture (%)	Rainfall (mm)
2014 September	32.2	16.5	24.7	0.6	35.5	27.4
2014 October	24.2	11.0	17.5	3.1	61.5	34.2
2014 November	14.5	2.9	8.3	2.8	71.4	97.6
2014 December	10.2	3.7	6.7	4.6	89.5	73.6
2015 January	7.6	2.2	2.3	3.5	81.2	64.6
2015 February	10.6	1.4	5.4	4.6	80.4	55.2
2015 March	14.2	2.6	8.2	3.9	74.4	127.0
2015April	19.2	5.5	12.4	4.9	69.6	48.6
2015 May	27.1	10.3	18.8	2.5	57.6	48.2
2015 June	34.4	15.9	26.1	1.5	34.5	7.4
2015 July	40.0	21.4	31.7	0.4	21.8	0
TOTAL						**583.8**

Table 1. The meteorological parameters of Diyarbakir Province where seed application and cultivation were made in December-2014

	AVERAGE VALUES	ANEMOLOGY	

DAY	MAX.TEMPERATURE	MİN. TEMPERATUREURE	AVER TEMPERATU	CLOUDİNESS	AVERAGE MOİSTURE	PRESSURE	SOİL SURFACE	SUN DURATİON	PRESSURE EXERTED ON THE SEA	MOST BLOWİNG DİRECTİON	AVERAGE SPEED	MAX. WİND DİRECTİON	MAX WİND SPEED	RAİN
1	17.7	7.6	11.7	4.7	87.7	934.3	7.0	0.1	1012.0	WSW	1.4	NNW	5.1	6.8
2	15.2	5.8	11.2	3.4	62.3	935.2	3.0	3.8	1013.2	WNW	3.6	NW	12.9	0.2
3	12.8	2.2	7.4	0.6	42.3	937.9	0.0	4.7	1016.7	N	2.5	NNE	11.9	
4	14.3	0.4	7.4	0.1	41.8	939.1	-3.0	8.7	1018.5	NNW	2.6	NNW	10.3	
5	15.0	-0.2	7.3	0.0	42.4	945.4	-3.0	8.6	1025.4	W	0.2	NE	6.2	
6	17.8	-0.9	8.6	0.0	46.9	946.8	-5.0	8.6	1026.6	W	0.1	NNW	5.2	
7	19.7	0.3	9.3	0.0	47.3	946.7	-4.0	8.5	1026.2	W	0.0	ENE	3.9	
8	17.9	-0.5	7.9	1.6	56.0	947.4	-4.0	8.4	1027.2	WSW	0.0	E	3.7	
9	18.1	-0.8	8.2	0.7	56.0	947.1	-5.0	6.8	1027.0	W	0.1	ESE	4.1	
10	19.0	1.1	9.4	1.2	51.1	945.6	-3.0	8.3	1025.1	W	0.0	E	3.8	
11	19.3	1.6	9.5	0.0	51.6	942.2	-3.0	7.9	1021.1	W	0.0	NE	3.8	
12	19.0	0.4	9.4	0.0	54.1	940.7	-3.0	7.9	1019.7	W	0.3	E	4.3	
13	18.7	1.3	9.5	1.0	54.2	941.1	-3.0	7.9	1020.1	ESE	0.4	ESE	4.6	
14	18.7	4.2	12.0	5.2	44.6	941.3	0.0	7.7	1019.8	E	0.9	ESE	5.1	
15	19.1	8.4	13.3	6.8	58.1	939.1	6.0	7.7	1016.9	NNE	1.0	E	8.0	
16	19.2	9.5	14.1	6.7	64.3	936.8	8.0	1.0	1013.9	E	2.7	E	10.1	0.0
17	14.2	9.9	10.9	4.9	94.8	939.6	9.0	3.3	1017.8	W	0.1	WSW	4.7	16.4
18	13.8	3.9	7.0	1.4	98.3	942.8	3.0	0.3	1022.2	WNW	0.9	W	3.6	0.2
19	15.6	1.8	7.8	1.5	92.0	944.7	0.0	7.6	1024.9	WNW	0.7	SE	3.8	
20	8.6	5.7	7.1	0.0	99.3	943.3	5.0	7.2	1023.0	WNW	1.1	W	2.4	
21	8.8	5.5	7.4	4.3	98.3	937.1	4.0	3.5	1016.4	E	1.3	E	3.8	
22	13.6	7.0	8.2	5.2	88.1	932.4	5.0	0.4	1010.8	S	3.3	S	7.7	38.8
23	10.5	1.8	5.4	2.4	94.5	937.4	1.0	4.6	1017.0	WSW	1.4	W	3.3	4.0
24	9.4	3.3	6.7	6.7	86.6	938.0	3.0	6.4	1017.5	W	1.7	WNW	3.5	0.2
25	10.8	3.1	6.4	4.4	85.3	936.7	3.0	6.4	1015.8	W	1.9	W	4.0	0.6
26	7.6	2.3	5.8	7.0	97.1	934.1	2.0	4.8	1013.5	ENE	1.2	NNE	3.1	0.4

27	9.3	1.5	6.3	6.2	92.0	937.5	4.0	4.8	1016.9	E	1.7	E	4.2	28.4
28	11.9	0.3	5.4	3.9	89.1	943.2	0.0	4.2	1023.3	ESE	1.3	W	3.1	1.4
29	12.4	-0.3	5.2	0.0	71.7	943.8	-3.0	5.4	1024.1	WSW	1.5	WSW	2.9	0.2
30	7.2	-3.6	2.9	4.3	94.4	941.8	-4.0	6.8	1022.9	ESE	1.2	ESE	3.0	
MAX	19.7	9.9	14.1	7.0	99.3	947.4	9.0	8.7	1027.2	X	3.6	X	12.9	38.8
MİN	7.2	-3.6	2.9	0.0	41.8	932.4	-5.0	0.1	1010.8	X	0.0	X	2.4	0.0
TOT.	435.2	85.6	248.7	84.2	2142.2	28219.1	20.0	172.3	30595.5	X	35.1	X	X	97.6
AVERAGE	14.5	2.9	8.3	2.8	71.4	940.6	0.7	5.7	1019.9	X	1.2	X	X	X
U.Z.AVER.									X	X		X		
% RATE									X	X		X		0

Average İsolation Duration % 5.7

Percentage of monthly sunbathing possible sunbathing: %57

Table 2. Metrological parameters of Diyarbakir Province from the foliar Esbioful application in March – 2014.

			AVERAGE VALUES							**ANEMOLOGY**				
DAY	MAX.TEMPERATURE	MİN. TEMPERATURE	AVER TEMPERATÜ	CLOUDİNESS	AVERAGE MOISTURE	PRESSURE	SOİL SURFACE	SUN DURATİON	PRESSURE EXERTED ON THE	MOST BLOWİNG DİRECTİO	AVERAGE SPEED	MAX. WİND DİRECTİO	MAX WİND SPEED	RAİN
1	15.5	-0.4	7.6	2.4	74.6	936.4	-3.0	5.9	1015.6	W	1.7	WSW	3.8	0.4
2	11.7	3.9	6.5	5.0	88.6	935.9	1.0	8.0	1015.1	SW	1.7	NNE	8.1	7.2
3	13.1	0.6	6.7	3.9	84.7	937.0	-1.0	8.0	1016.5	W	1.3	NE	3.0	2.0
4	11.4	3.4	6.7	4.6	75.2	937.0	2.0	5.0	1016.1	S	1.1	NNW	2.6	
5	11.0	1.9	5.0	0.7	44.4	943.7	-1.0	5.0	1023.8	NW	6.7	NW	13.5	3.4
6	13.3	**-4.4**	4.8	2.3	53.4	947.9	-8.0	9.9	1029.0	W	1.9	W	3.8	
7	16.0	-1.8	6.9	3.3	61.1	944.6	-4.0	9.9	1024.7	WNW	1.2	N	2.6	
8	16.9	0.8	8.4	2.3	65.8	942.3	-2.0	9.0	1021.7	SW	1.0	WSW	2.3	

9	**20.0**	0.3	10.1	0.0	66.0	941.9	-3.0	8.6	1020.7	WSW	1.2	SE	2.5	
10	19.7	0.6	10.3	0.0	53.7	944.8	-2.0	9.8	1023.7	W	1.6	W	4.2	
11	16.8	-0.1	10.2	3.5	54.3	941.9	-3.0	9.9	1020.8	W	1.7	WSW	3.6	
12	15.0	7.1	8.8	6.7	78.6	936.3	5.0	9.9	1014.7	NNE	2.0	NNE	5.0	0.2
13	13.6	3.7	8.3	3.7	81.7	940.6	2.0	7.7	1019.8	WSW	1.8	W	4.9	21.6
14	17.2	1.7	9.5	2.0	73.5	940.2	-1.0	3.9	1019.1	W	1.8	W	3.9	
15	17.3	2.5	10.1	2.9	69.8	938.9	-1.0	9.4	1017.4	W	2.4	WSW	4.5	
16	11.4	2.4	7.2	5.3	85.1	936.3	0.0	9.4	1015.2	WNW	1.3	NNE	3.5	1.6
17	12.6	4.2	7.7	4.6	80.7	938.8	2.0	7.2	1018.0	SW	1.4	WNW	3.5	1.8
18	14.3	-0.7	7.5	3.1	78.0	940.7	-2.0	5.1	1020.2	WSW	1.4	WSW	3.3	
19	10.2	1.9	6.9	6.7	84.5	937.2	-1.0	8.2	1016.5	W	2.2	NNE	5.4	0.0
20	13.7	6.4	8.6	6.0	81.6	932.3	6.0	8.2	1010.8	W	2.1	WSW	4.0	11.2
21	12.1	4.6	7.5	6.3	78.4	931.7	3.0	2.3	1010.1	S	2.6	SSW	7.1	2.4
22	**8.5**	1.0	**4.2**	5.1	82.7	933.0	1.0	3.3	1012.7	ESE	2.6	ESE	5.4	17.4
23	13.7	-1.2	8.1	2.2	64.6	939.2	-4.0	3.5	1018.6	WNW	2.5	SSE	6.3	1.2
24	9.5	6.2	7.6	7.5	88.2	940.1	5.0	8.5	1019.4	E	2.0	E	5.9	4.4
25	8.9	6.8	6.2	5.4	91.6	941.6	6.0	8.5	1021.1	ENE	2.3	E	6.3	2.8
26	18.0	-1.2	9.3	0.0	68.2	942.5	-3.0	0.0	1021.9	W	1.8	W	4.7	9.6
27	18.4	2.7	11.0	3.3	64.5	942.4	0.0	10.5	1021.2	WNW	1.8	WNW	5.5	
28	16.2	6.5	**11.4**	6.6	81.5	938.9	4.0	10.5	1017.2	WSW	1.3	WSW	3.2	
29	13.1	9.9	10.9	7.5	90.8	934.9	9.0	9.3	1012.6	NE	1.7	NNE	4.6	3.0
30	17.1	8.9	11.2	3.9	75.9	930.1	8.8	2.1	1007.4	SW	3.2	S	9.9	**36.8**
31	14.8	2.3	10.1	5.6	83.8	933.7	1.0	7.0	1011.9	W	1.6	W	3.6	0.0
MAX	**20.0**	9.9	11.4	7.5	91.6	947.9	9.0	10.5	1029.0	X	6.7	X	13.5	36.8
MİN	8.5	-4.4	4.2	0.0	44.4	930.1	-8.0	0.0	1002.4	X	1.0	X	2.3	0.0
TOP	441.0	80.5	255.3	122.4	2305.5	29102.8	16.8	223.5	31553.5	X	60.9	X	X	127.0
ORT	14.2	2.6	8.2	3.9	74.4	938.8	0.5	7.2	1017.9	X	2.0	X	X	X
AV. SP.									X	X		X		
% RATIO									X	X		X		
Average İsolation Duration:						7.2								
Percentage of monthly sunbathing possible sunbathing: %										61				