Research Result Report of ESBIOFUL (*Pseudomonas fluorescens*) Commercial Preparation on Activity of Red Lentil

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 red lentil.

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 "CAGIL" red lentil 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 lentil were kept for 30 minutes and were vaccinated. Foliar application of lentil 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 300 seeds per square meter. In the study: % number of days of flowering (days), mature day period (days), plant height (cm), first bean height (cm), grain yield (kg / da), biological yield (kg / da), number of grain in the plant (pcs), 1000 grain weight (g), harvest index (%), number of main branches in plant (pcs), number of beans in the plant (pcs), and number of grain in plant (pcs) 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 lentil, %number of flowering days, mature day period, plant height, first bean height, grain yield, biological yield, number of grain in the plant, 1000 grain weight, harvest index, number of main branches in plant, number of beans in the plant, and number of grain in plant, average values and resulting groupings of the characteristics are given in Tables 1 and 2. When the number of Tables 1 and 2 are examined, the effect of ESBIOFUL applications on the number of flowering days and seed yield in red lentils is at 0.01 level; the number of main branches in the plant, the number of grains in the plant and the harvest index is significant at 0.05 level; and the effect on other examined features was found to be statistically insignificant.

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In the study, the harvest index values varied between 29.9% and 34.4%. While the lowest harvest index was determined in the control method with no application, the highest harvest index was determined by seed vaccination + foliar application method. However, three application methods of ESBIOFUL preparation were included in the same group and no difference was found between these three methods in terms of efficacy (Table 1).

Table 1. The effect of ESBIOFUL applications on the number of flowering days of lentils, day of ripening, plant height, first bean height, harvest index and the effect on biological yield

Applications	% Number of flowering days (days)	Mature day time (day)	Plant height (cm)	First bean height (cm)	Harvest index (%)	Biological yiled (kg/da)
T 1 (Control)	123.2 a	151.8	34.8	13.0	29.9 b	631.9
T2 (1 L/l ton seed vaccination)	121.5 b	150.5	34.4	14.0	34.1 a	638.9
T3 (Foliar application)	122.7 a	150.3	33.9	12.8	33.8 a	625.0
T4 (seed vaccination + foliar application)	122.0 b	149.5	34.7	13.2	34.4 a	635.4
Averagea	122.4	150.5	34.7	13.2	33.1	632.8
CV (%)	1.2	2.4	3.51	5.17	5.42	6.87
LSD	0.60**	NS	NS	NS	2.87*	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 yield per decare, which was statistically significant at 0.01 level, varied between 196.3 and 222.0 kg / da. Seed yields were collected in different groups and the highest seed yield was obtained from seed vaccination + foliar application method. This application method was found to provide a higher yield increase by 13.1% compared to the control application. However, there was no difference in efficiency between seed vaccination and foliar application method (Table 1).

Table 2. Effect of ESBIOFUL applications on lentil 1000 grain weight, number of main branches in the plant, number of beans, number of seeds and grain yield in the plant.

Applications	1000 grain weight (g)	Number of main branches in the plant (pcs)	Number of beans in plant (pcs)	Number of seeds in plant (pcs)	Grain yield (kg/da)
T1(Control)	27.0	2.3b	55.2	63.8	196.3 c
T2 (1L/1 ton seed vaccination)	27.4	2.5 a	62.4	71.0 a	210.4 b
T3 (Foliar application)	26.8	2.3 b	58.6	69.7 a	208.8 b
T4 (Seed vaccination + foliar application)	27.7	2.4 ab	62.5	71.7 a	222.0 a
Average	**27.2**	**2.4**	**59.6**	**69.1**	**209.4**
CV (%)	**4.11**	**4.21**	**8.21**	**5.23**	**3.1**
LSD	**NS**	**0.16***	**NS**	**5.78***	**10.22***

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 Element Content in Lentil:

The results of the analysis of some macro and micro element (Al, Ca, Cr, Cu, Fe, K, Mg, Mn, P, Se and Zn) contents of lentil of different applications of ESBIOFUL commercial preparation used in this study are given in Table 3.

Table 3. ESBİOFUL applications (Al, Ca, Cr, Cu, Fe, K, Mg, Mn, P, Se and Zn) are analyzed in lentil (element) (mg / kg)

Applications	Al	Ca	Cr	Cu	Fe	K	Mg	Mn	P	Se	Zn
Tl (Control)	57.47 b	280.95	0.332 b	7.85	52.91 b	5913.90	800.31	11.08	627.04	0.553	17.77 b
T2 (1 L/1 ton seed vaccination)	104.7 b	254.66	0.379 b	7.66	61.72 b	5897.43	807.88	11.33	641.27	0.585	17.20 b
T3 (Foliar application)	274.2 a	249.42	0.599 a	8.01	93.49 a	6054.07	851.63	12.53	717.79	0.671	19.39 a
T4 (Seed vaccination + foliar application)	288.1 a	290.55	0.481 ab	7.96	63.59 b	6086.30	873.73	11.91	656.76	0.550	17.78 b
DK %	14.70	9.36	12.93	3.59	12.01	1.93	4.74	10.39	8.89	15.07	2.65
LSD	185.37*	ns	0.127*	ns	22.66*	ns	ns	ns	ns	ns	1.16*

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 ESBIOFUL applications on the red lentil contents of Al, Cr, Fe and Zn were statistically significant at 0.05 level and the effect of Ca, Cu, K, mg, Mn, P and Se contents was insignificant. The highest value in terms of the amount of all found statistically significant was obtained from seed insemination + foliar application method, while the highest values in terms of Cr, Fe and Zn contents were obtained from foliar application method. At the end of the study, statistically insufficient in terms of Ca, Cu, K, Mg, Mn, P, and Se contents, the highest values were obtained from seed vaccination + foliar application method.

Conclusion: With the results of the research carried out and the results given above, was determined that ESBIOFUL (*Pseudomonas Fluorescens*) commercial preparation in red lentils; the number of flowering days, number of major branches in

plant, number of grains in the plant, harvest index and grain yield in the grain has a positive effect on the Al, Cr, Fe and Zn element contents and these effects have been statistically significant. As a result of the research, **foliar application** method in terms of elemental contents of Cr, Fe, P, Se and Zn in the grain, while the yield of grain yield per decare of Al, Ca, Cu, K, Mg and Mn element in terms of **seed vaccination + foliar application** method is the most prominent application. It was observed that the yield of seed preparation in the application of ESBİOFUL commercial preparation **seed vaccination + foliar application** method yielded a 13.1% higher yield increase in the control application where the preparation was not applied. (21.08.2015).

Best regards,

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

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

DAY	AVERAGE VALUES									ANEMOLOGY				
	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. Meteorological parameters of Diyarbakir Province from the foliar Esbioful application in March - 2014

			AVERAGE VALUES							**ANEMOLOGY**				
DAY	MAX.TEMPERATURE	MİN. TEMPERATURE	AVER TEMPERAT	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				