Efficiency of biofertilizers in Southern and Eastern Russia

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Symbiotic and free-living N-fixing bacteria are major microorganisms used to produce effective bacterial fertilizers. There are no industrial bacterial products able to noticeably increase the availability of P and K in the soil. Results on the efficiency of bacterial fertilizers increasing, according to producers, soil P and K availability are somewhat contradictory. Below are results from some field experiments with biofertilizers conducted in S&E Russia:

Table 1. Effect of mineral and bacterial* fertilizers on the yield of pulse crops on common chernozems (adapted from: Agafonov, 2008)

Bacterium strain**	Fertilizer treatment (N, P_2O_5)	Yield increase, t/ha		Yield increase, %	
		Mineral fertilizers	Bacterial fertilizers	Mineral fertilizers	Bacterial fertilizers***
Field pea, 1996-1998 average (yield at the control = 1.76 t/ha)					
263	N25P80	0.31	0.25	18	12
	N50P80	0.34	0.22	19	10
626	N25P80	0.31	0.07	18	3
	N50P80	0.34	0.04	19	2
261	N25P80	0.31	0.03	18	1
	N50P80	0.34	0.01	19	0
Soybean, 2000-2002 average (yield at the control = 1.51 t/ha)					
634b	N30P90	0.22	0.50	15	29
	N60P90	0.42	0.51	28	26
	N90P90	0.63	0.42	42	20
645b	N30P90	0.17	0.15	11	9
	N60P90	0.39	0.18	26	9
	N90P90	0.66	0.16	44	7
640b	N30P90	0.14	0.32	9	19
	N60P90	0.36	0.34	24	18
	N90P90	0.62	0.32	41	15
Chickpea (*Cicer arietinum*), 2001-2003 average (yield at the control = 1.71 t/ha)					
H-18	N12.5P50	0.40	0.19	23	9
	N25P50	0.28	0.10	16	5
522	N12.5P50	0.28	0.28	16	14
	N25P50	0.13	0.16	8	9
527	N12.5P50	0.31	0.51	18	25
	N25P50	0.13	0.37	8	20

* Seed inoculation with "Rizotorphin": 5-8 x 10^9 rhizobial bacteria per 1 g of peat (Dyatlova, 2001)
** Collection of the Russian Research Institute of Agricultural Microbiology:
http://www.arriam.spb.ru/eng/lab10/docs/Catalog2010.pdf
*** Yield increase from bacterial fertilizer compared to treatments with mineral fertilizer application

Table 2. Effect of seed inoculation with "Rizotorphin"* and "Azotobacterin" (*Azotobacter chroococcum*) on the yield of soybean** on the leached chernozem (Zaostrovnykh and Simkina, 2009)

Treatment	Yield, t/ha			Yield increase, %
	2007	2008	Mean	
Control	0.76	0.82	0.79	-
+ "Rizotorphin"	0.95	0.96	0.96	22
+ "Azotobacterin"	0.95	0.96	0.96	22
+ "Rizotorphin" and "Azotobacterin"	1.08	1.12	1.10	39

* "Rizotorphin": 5-8 x 10^9 rhizobial bacteria per 1 g of peat (Dyatlova, 2001)
** Soybean was planted after fallow, treatments with mineral fertilizer use were not studied

Table 3. Effect of seed inoculation with "Rizotorphin"* on yield parameters of broad bean (*Vicia faba* L.) on the leached chernozem, 2005-2008 average (Timoshkin, 2009)

Sowing method	Treatment	DM yield, t/ha	DM yield increase, %	Grain yield, t/ha	Grain yield increase, %	Protein yield, kg/ha	Protein yield increase, %
Narrow rows, 0.6 x 10^6 PLS/ha	Control	5.95	-	2.39	-	722	-
	+ "Rizotorphin"	7.17	21	2.66	11	951	32
	NPK**	7.38	-	2.76	-	1001	-
	+ "Rizotorphin"	8.11	10	3.03	10	1117	12
Wide rows, 0.2 x 10^6 PLS/ha	Control	7.26	-	3.59	-	768	-
	+ "Rizotorphin"	8.45	16	3.92	9	975	27
	NPK**	8.68	-	3.58	-	1023	-
	+ "Rizotorphin"	9.06	4	3.93	10	1083	6

* "Rizotorphin": 5-8 x 10^9 rhizobial bacteria per 1 g of peat (Dyatlova, 2001)
** Fertilizer rates calculated using the balance method for yield goal of 3 t/ha

Table 4. Effect of seed inoculation with "Rizotorphin"* on the yield of narrow-leafed lupin (*Lupinus angustifolius* L.) and lentil on the leached chernozem (Karpova, 2010)

Treatment (N, P_2O_5, K_2O)	Yield, t/ha				Yield increase, %
	2005	2006	2007	Mean	
Narrow-leafed lupin					
Control	1.93	1.95	1.30	1.73	-
+ "Rizotorphin"	2.14	2.08	1.39	1.87	8
P60K40	2.07	2,09	1.46	1.87	-
+ "Rizotorphin"	2.21	2.26	1.53	2.00	7
Lentil					
Control	1.32	1.63	1.10	1.35	-
+ "Rizotorphin"	1.79	1.78	1.19	1.59	18
P60K40	1.77	1.85	1.22	1.61	-
+ "Rizotorphin"	1.99	1.95	1.25	1.73	7

* "Rizotorphin": 5-8 x 10^9 rhizobial bacteria per 1 g of peat (Dyatlova, 2001)

Table 5. Effect of seed treatments with "Rizoagrin" (*Agrobacterium radiobacter*) on the yield of winter wheat* on the light-chestnut soil (Balashov *et al.*, 2008)

Variety	Treatment	Yield, t/ha			Yield increase, %
		2007	2008	Mean	
1	Control	0.85	2.74	1.79	-
	+ "Rizoagrin"	1.24	2.88	2.06	15
2	Control	1.06	2.84	1.96	-
	+ "Rizoagrin"	1.20	3.12	2.11	8
3	Control	1.23	2.79	2.01	-
	+ "Rizoagrin"	1.38	3.09	2.23	11
4	Control	1.16	2.88	2.02	-
	+ "Rizoagrin"	1.36	3.18	2.27	12

* Winter wheat was planted after fallow, treatments with mineral fertilizer use were not studied

Table 6. Effect of seed treatments with "Rizoagrin" (*Agrobacterium radiobacter*) on the yield of spring wheat on the grey forest soil (Karimov and Zaripov, 2007)

Treatment (N, P_2O_5, K_2O)	Yield, t/ha				Yield increase, %
	2002	2003	2004	Mean	
Control	3.33	3.22	2.06	2.87	-
+ "Rizoagrin"	3.84	3.70	2.42	3.32	16
P45K60	3.48	3.35	2.17	3.00	-
+ "Rizoagrin"	3.91	3.81	2.51	3.41	14
N30P45K60	3.86	3.76	2.28	3.30	-
+ "Rizoagrin"	3.95	3.80	2.50	3.42	4
N60P45K60	3.97	3.82	2.59	3.46	-

Table 7. Effect of seed treatments with "Baikal EM-1"* on yield and quality of spring triticale on the leached chernozem, 2008-2009 average (Kshnikatkina and Semikova, 2010)

Treatment**	Yield, t/ha	Yield increase, %	1000 grain weight, g	Grain test weight, g/l	Grain glassiness, %
Control	2.69	-	41.0	761	47.0
+ "Baikal EM-1"	2.96	10	42.1	767	55.0

* Biofertilizer containing bacteria, fungi, and actinomycetes (according to producers)
** Treatments with mineral fertilizer use were not studied

Table 8. Effect of seed treatments with "Baikal EM-1"* and "Rizoagrin" (*Agrobacterium radiobacter*) on the yield of sugar beet on the leached chernozem, 2006-2008 average (Kulikova and Dronina, 2009)

Treatment	Yield, t/ha				Yield increase, %
	2006	2007	2008	Mean	
Control	25.6	46.5	28.2	33.4	-
+ "Baikal EM-1"	33.3	52.3	34.9	40.2	20
+ "Rizoagrin"	33.4	51.8	33.1	39.4	18
N60P60K60	34.0	54.5	37.5	42.0	-
+ "Baikal EM-1"	36.1	53.9	40.4	43.5	4
+ "Rizoagrin"	34.7	52.3	37.0	41.3	- 2

* Biofertilizer containing bacteria, fungi, and actinomycetes (according to producers)

Table 9. Effect of tuber treatments with "Ekophit" (*Azotobacter chlorococcum*) on the yield of potato on the soddy-podzolic light-textured soil (Fedotova *et al.*, 2009)

Treatment (N, P_2O_5, K_2O)	Yield, t/ha			Yield increase, %
	2007	2008	Mean	
N90P90K120	11.6	31.7	21.7	-
+ "Ekophit", 0.02 l/t	15.4	30.0	22.7	5
+ "Ekophit", 0.19 l/t	16.5	34.6	25.6	18
+ "Ekophit", 1.90 l/t	15.5	40.1	27.8	28
+ "Ekophit", 18.80 l/t	14.9	37.4	26.2	21

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