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Research Article

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Investigation the Effects of Different Doses Organic Fertilizers and Phosphate Solubilizing Bacteria on the Yield and Nutrient Contents in Chickpea (*Cicer arietinum* L.)

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Abstract: The study was conducted to determine the effect of phosphate solubilizing bacteria (N2; *Bacillus megaterium* M-3, TV-6I; *Cellulosimicrobium cellulans*, TV-34A; *Hafnia alve*, TV-69E; *Acetobacter pasteurianus* and TV-83F; *Bacillus cereus*) and organic fertilizer (0 10 ton/ha and 20 ton/ha) on the seed yield and nutrient content of chickpea under field conditions in 2010 and 2011 growing seasons. Phosphate solubilizing bacterias used in this study were determined by the separate investigation conducted in chamber room by using ten phosphate solubilizing bacteria and organic fertilizer (control, %5 and %10). The trial were laid out with a factorial design in randomized complete block with three replications. In this study, plant height, primary branches, secondary branches and number of pods per plant, number of seeds per pod, grain yield and biological yield and nutrient content of stem and seed were determined. According to the results of the study bacteria applications increased significantly biological and seed yield. Bacteria applications without organic fertilizer increased nutrient contents of seed and steed except cupper content. In case of inoculation with organic fertilizer provided more increases in biological and seed yields. The highest seed yield were obtained from application of 20 ton/ha + N2 (*Bacillus megaterium* M-3) with 1020 kg/ha and 1793 kg/ha in 2010 and 2011 years, respectively. Bacteria without organic fertilizer application were more active in terms of phosphorus uptake in both years.

***Keywords**:* Nutrients; PSB; organic manure; phosphorus; chickpea

1. Introduction

Phosphate Solubilizing Bacteria (PSB) treatments were expanded together fertilization, irrigation reclamation etc. by aim of maximum yield and quality in agricultural lands. These bacteria changes due to their functions such as nitrogen bacteria, potassium bacteria, phosphorus bacteria etc.

Phosphate solubilizing bacteria have important role in uptaking phosphorus by plants and plant nutrition. The performance of these bacteria changes due to variety of plant, climate and soil conditions (Cakmakcı, 2005).

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Nitrogen and carbon content of soil, and buffering capacity of soil also effects their activities (Cunningham and Kuiack, 1992; Whitelaw, 2000; Sangeeta and Nautiyal, 2001; Pradhan and Sukla, 2005; Xie, 2008). Cakmakcı (2005) reported that there are two relations among PSB and plants as rhizospheric an entophytic.

Taha *et al.* (1969), the share of the total microflora of soil phosphate solvent microorganisms according to their reported that less than 1% so reported that widespread use as a bio fertilizer of phosphate solvent microorganisms to increase the share of the microflora in many countries. Phosphate solvent microorganisms as *Pseudomonas* and *Bacillus* bacteria species, fungi; *Penicillium, Aspergillus* species and actinomycetes; *Proteus, Serratia* and forms *Micrococcus* species. These organisms form insoluble plant available phosphorus in the form of various acids are secreted conversion process. These are: formic, acetic, propionic, lactic, glyoxalic, gluconic, fumaric, tartaric and succinic acids (Ilmer *et al.,* 1992; Whitlew *et al.,* 1999).

In rhizospheric relation, PSB can be colonize in rhizosphere and replace in root surface or intracellular areas. A food legume has low lipit concentration as check and, not contains cholesterol. These are useful for human health because of having some vitamins (A, B, C and E) and minerals (Ca, Fe). It was aimed that determination of effects of PSB and organic fertilizer applications on nutrient uptaking in chickpea.

2. Materials and Methods

2.1.Plant materials

Field trials were conducted in 2009-10 and 2010-11 at the Faculty of Agriculture, Van Yuzuncu Yıl University. As the plant material in the trial, it has adapted well to the conditions Aziziye-94 chickpea cultivars used.

Analysis of soil and plant samples: In the analysis of soil, the texture was determined by Bouyoucous' hydrometric method (Bouyoucous, 1951), pH in 1:2.5 soil: water suspension (Jackson, 1969), lime by calcimetric methods (Kacar, 1994), organic matter by the modified Walkley Black method (Walkley, 1947), salt content by Richards (Richards, 1954), total nitrogen by Kjeldahl method (Kacar, 1994), available phosphorous by the method Olsen (Olsen *et al.*, 1954), potassium, calcium and magnesium by an extraction with 1 N neutral ammonium acetate (Thomas, 1982), available iron, manganese, zinc, and copper by mixing with dipropylenetriamine (DTPA) (Kacar, 1994).

For mineral content analysis, plant samples were oven-dried at 68 ^{o}C for 72 h and then were ground. Nitrogen was determined by Kjeldahl method (Kacar and İnal 2008), phosphorous was determined by spectrophotometrically by the indo-phenol-blue method (Kacar and İnal 2008). Potassium, calcium, iron, manganese, zinc, and copper contents in the extracts were determined using atomic absorption spectrophotometry (Kacar and İnal 2008).

The plant criterias, that plant height, number of primary branches, number of pods per plant, grain yield and biological yield, were determined as Tosun and Eser (1975).

3. Results and Discussions

The effects of PSB applications on grain yield and biological yield were found significant ($P<0.01$) in two years conducted research. Increasing organic fertilizer treatments significantly ($P<0.05$) effected plant length and biological yield in first year of research. In the second year of research statistically ($P<0.01$) biological yield was influenced by organic fertilizer treatments. The PSB x organic fertilizer interactions have effect on biological yield in the first year. PSB applications clearly increased grain yield with organic fertilizer applications (Table 2). It was noticed organic fertilizer applications, the highest grain yield was obtained as 913 kg ha^{-1} and 1063 kg ha^{-1} in first year and second year by 20 ton ha^{-1} organic fertilizer. These increases occurred as 22.2% and 14.4% according to means in the control, respectively. Similarly PSB treatments increased grain yield in both of years. The highest grain yields were determined as 958 kg ha^{-1} with TV-69E organisms in first and second year respectively. When these increases regarded according to control, grain yield increased 29.3% and 46.0% in first and second year respectively. PSB treatments also increased biological yield especially with organic fertilizers applications.

The highest grain yield was obtained as 2477 kg ha^{-1} with TV-6I organisms and 4023 kg ha^{-1} with N2 organisms in first and second year respectively. The increases according to control were determined as 31.8% and 31.9% in first and second year respectively. Increasing organic fertilizer doses increased biological yield. When macro nutrient contents of straw an grain were noticed that PSB applications had significant ($P<0.01$) effects on N and P, K and Ca contents ($P<0.05$) of straw in second year of research (Table 2). Organic fertilizers applications had also significant effects on N, K and Ca contents of straw. The highest nitrogen content means of straw were obtained as 0.763% and 0.725% in 20 ton ha^{-1} organic fertilizer application and TV-6I organisms, respectively (Table 3).

The potassium contents of straw increased by increasing organic fertilizer doses. The highest K contents were obtained as 1.342% and 3.230% in first and second years respectively by 20 ton ha^{-1} organic fertilizer applications. The highest Ca content of straw was obtained as 2.050% in second year of research. Increasing organic fertilizer doses iron contents of straw increased in second year. The highest iron content was found as 545 mg kg^{-1}, in 20 ton ha^{-1} organic fertilizer application. These increase occurred in 108% ratio compare with iron mean obtained in first year. Organic fertilizer application as 10 ton ha^{-1} increased zinc and manganese contents of straw according to control. PSB treatments had significant effect on iron contents of straw in second year. While the highest iron content was obtained as 458 mg kg^{-1} with N2 organisms and these increase were found in ratio as 30.5% according to control. The highest Mn content of straw and Zn content of gain were obtained as 45.60 mg kg^{-1} and 12.49 mg kg^{-1} with N2 organisms in first year. Copper contents of straw and grain were decreased by PSB treatments. These increases were found in 342.9% and 17.2% with TV-69E organisms. PSB treatment increased MN and Zn contents of grain, Copper contents of grain decreased by PSB treatments. The highest Mn and Zn contents of grain were found as 28.0 mg kg^{-1} and 12.49 mg kg^{-1} with TV-6I organisms and N2 organisms respectively (Table 5).

As a result, it was determined that PSB treatments without organic fertilizer applications had higher positive effects on micronutrient contents of chickpea. The highest seed yield were obtained from application of 20 ton ha^{-1}+N2 (*Bacillus megaterium* M-3) with 1020 kg ha^{-1} and 1793 kg ha^{-1} in 2010 and 2011 years, respectively. Bacteria without organic fertilizer application were more active in terms of phosphorus uptake in both years. It was thought that organic fertilizer applications are not essential in PSB treatments. Also, organic fertilization should be avoided to have optimum microbial activity in soil.

Table 1. Some physical and chemical properties of experimental soil and sheep manure

	pH	Salinity (μS/cm)	Lime (%)	O.M. (%)	Texture	N (%)	P (mg kg^{-1})	K	Ca	Mg	Fe	Mn	Zn	Cu
Soil														
2009-10	8.05	305	7.6	0.15	SCL	0.099	4.6	184	2074	75	4.86	18.6	0.49	0.76
2010-11	8.18	238	6.3	0.48	SCL	0.049	7.5	421	3512	119	5.81	20.4	0.40	1.29
Organic fertilizer														
2009-10	8.54	685	-	91	-	3.28	1109	3969	5976	4642	52	151	20.53	6.92
2010-11	8.69	665	-	92	-	3.36	1221	4103	6852	4824	54	150	18.14	6.13

Table 2. The effects of bacteria and organic manure application on plant growth criteria and nutrient uptake by chickpea

Treatments	Plant height		The first branch		The second branch		The number of pods		The number of seed per		Grain yield		Biological yield	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
Block	1.70^{ns}	2.65^{ns}	1.41^{ns}	4.00*	8.11**	3.46*	2.18^{ns}	10.02***	8.12**	1.62^{ns}	9.79***	9.79***	4.59*	3.13^{ns}
Bacteria	0.93^{ns}	0.23^{ns}	0.48^{ns}	1.69^{ns}	0.88^{ns}	0.79^{ns}	1.33^{ns}	0.33^{ns}	1.12^{ns}	2.13^{ns}	9.23***	9.23***	7.75**	13.50***
Organic fertilizer	3.72*	0.25^{ns}	0.32^{ns}	0.92^{ns}	1.92^{ns}	2.56^{ns}	1.20^{ns}	2.03^{ns}	2.13^{ns}	0.76^{ns}	13.14***	13.14***	5.72*	6.64**
Bacteria x organic fertilizer	1.98^{ns}	0.43^{ns}	1.55^{ns}	0.85^{ns}	0.95^{ns}	0.41^{ns}	0.20^{ns}	1.85^{ns}	1.59^{ns}	0.83^{ns}	1.98^{ns}	1.97^{ns}	2.97*	0.36^{ns}

	Nitrogen				Phosphorus				Potassium				Calcium			
	Straw		Grain		Straw		Grain		Straw		Grain		Straw		Grain	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
Block	1.12^{ns}	4.83*	1.46^{ns}	0.95^{ns}	0.63^{ns}	0.56^{ns}	0.66^{ns}	0.32^{ns}	0.79^{ns}	0.48^{ns}	2.82^{ns}	0.85^{ns}	0.85^{ns}	3.65*	0.61^{ns}	0.12^{ns}
Bacteria	1.68^{ns}	5.06**	0.63^{ns}	0.66^{ns}	0.73^{ns}	3.87*	0.50^{ns}	1.52^{ns}	0.98^{ns}	3.64*	2.26^{ns}	1.53^{ns}	1.25^{ns}	4.76*	0.91^{ns}	0.11^{ns}
Organic fertilizer	2.34^{ns}	19.14***	3.71*	1.34^{ns}	0.54^{ns}	1.56^{ns}	0.84^{ns}	1.86^{ns}	4.24*	6.37**	0.01^{ns}	0.95^{ns}	0.30^{ns}	6.24**	0.49^{ns}	0.32^{ns}
Bacteria x organic fertilizer	1.71^{ns}	5.22**	1.03^{ns}	1.05^{ns}	5.74**	0.61^{ns}	0.86^{ns}	0.91^{ns}	0.36^{ns}	0.93^{ns}	5.00 **	0.53^{ns}	1.48^{ns}	0.35^{ns}	1.59^{ns}	1.64^{ns}

	Iron				Manganese				Zinc				Cupper			
	Straw		Grain		Straw		Grain		Straw		Grain		Straw		Grain	
	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
Block	3.40^{ns}	1.72^{ns}	3.72*	1.11^{ns}	1.51^{ns}	0.34^{ns}	3.02^{ns}	0.37^{ns}	0.68^{ns}	0.04^{ns}	2.15^{ns}	2.91^{ns}	2.10^{ns}	4.86*	1.11^{ns}	2.38^{ns}
Bacteria	1.35^{ns}	2.40^{ns}	0.49^{ns}	1.66^{ns}	2.77^{ns}	1.33^{ns}	3.28*	0.44^{ns}	1.04^{ns}	0.19^{ns}	6.88**	1.47^{ns}	230.86***	1.74^{ns}	92.56***	2.51^{ns}
Organic fertilizer	0.22^{ns}	28.00***	3.87*	2.41^{ns}	0.99^{ns}	5.46^{ns}	1.12^{ns}	1.93^{ns}	0.39^{ns}	4.36*	1.92^{ns}	0.21^{ns}	0.22^{ns}	0.36^{ns}	4.67*	1.92^{ns}
Bacteria x organic fertilizer	3.92**	0.59^{ns}	1.64^{ns}	0.92^{ns}	2.65^{ns}	0.89^{ns}	1.33^{ns}	1.54^{ns}	1.39^{ns}	1.28^{ns}	2.64*	0.70^{ns}	10.22***	0.53^{ns}	5.65**	0.56^{ns}

*, %5; **, %1; ***, %0.1; ns, non significant

Table 3. Mean values of the bacteria and organic manure applications on some of yield and yield parameters in chickpea

Organic manure doses (ton/ha)	Bacteria codes	Plant height (cm)		The first branch (units plant^{-1})		The second branch (units plant^{-1})		The number of pods (units plant^{-1})		The number of seed per pods (units plant^{-1})		Grain yield (kg ha^{-1})		Biological yield (kg ha^{-1})	
		2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
Control	Control	28.5	36.8	2.13	3.13	3.87	2.07	11.43	9.67	7.73	6.30	627	927	1590	2390
	TV-6I	24.5	37.0	2.10	3.03	3.97	1.60	8.90	8.93	7.50	8.73	720	1543	1930	3427
	N2	29.1	35.6	2.10	3.63	4.70	1.77	15.67	11.20	15.27	11.30	897	1533	1860	3380
	TV-69E	26.4	32.9	3.10	2.23	3.73	1.67	9.33	8.63	8.43	8.77	743	1600	1843	3410
10	Control	27.7	34.9	2.60	2.98	4.60	0.93	14.53	7.97	9.47	7.60	733	1163	1623	2737
	TV-6I	29.2	34.8	2.23	2.73	3.90	1.77	14.70	8.43	14.60	7.80	887	1607	1923	3470
	N2	29.4	33.5	2.47	3.13	3.90	0.70	13.20	8.70	12.60	8.60	957	1430	2127	3387
	TV-69E	30.6	35.8	1.67	3.20	5.60	0.80	16.56	6.90	16.50	6.53	1017	1720	2443	3723
20	Control	28.5	36.4	1.97	3.30	4.60	1.33	12.50	8.93	11.50	8.73	863	1307	1803	3050
	TV-6I	26.7	35.3	2.37	2.93	4.87	1.57	13.63	6.67	14.37	6.53	923	1670	2477	3743
	N2	25.3	34.7	2.60	3.37	4.60	1.00	7.80	10.03	9.67	9.57	1020	1793	2143	4023
	TV-69E	28.1	37.1	2.97	2.83	5.67	0.93	16.20	7.13	14.37	6.73	840	1640	1970	3913
Averages of organic fertilizer	Control	27.2 B	35.6	2.36	3.01	4.07	1.78	11.33	9.60	9.73	8.78	747 B	1401 B	1806 B	3152 B
	10 ton/ha	29.2 A	34.8	2.24	3.00	4.50	1.05	14.75	8.00	13.29	7.63	898 A	1480 AB	2029 A	3329 B
	20 ton/ha	27.2 B	35.9	2.48	3.11	4.93	1.21	12.53	8.19	12.48	7.89	913 A	1603 A	2098 A	3683 A
Average of bacteria applications	Control	28.2	36.1	2.23	3.14	4.36	1.44	12.82	8.86	9.57	7.54	741 C	1132B	1672 B	2726 B
	TV-6I	26.9	35.7	2.23	2.90	4.24	1.64	12.41	8.01	12.16	7.69	844 B	1607 A	2110 A	3547 A
	N2	27.9	34.6	2.39	3.38	4.40	1.16	12.22	9.98	12.51	9.82	958 A	1586 A	2043 A	3597 A
	TV-69E	28.4	35.3	2.58	2.76	5.00	1.13	14.03	7.55	13.10	7.34	867 B	1653 A	2086 A	3682 A

*, %5; **, %1; ***, %0.1; ns, non significant; A, B, C; the difference between the averages indicated by the same letter is not significant

Table 4. Mean values of the bacteria and organic manure applications on the macro nutrients

Organic manure doses (ton ha^{-1})	Bacteria codes	Nitrogen (%)				Phosphorus (mg k^{-1})				Potassium (%)				Calcium (%)			
		Straw		Grain		Straw		Grain		Straw		Grain		Straw		Grain	
		2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
Control	Control	0.778	0.569 b	3.530	3.332	335	1442	2520	4291	1.255	2.511	0.993 a	1.086	1.042	1.681	0.116	0.195
	TV-6I	1.131	0.495 b	3.965	2.999	509	2017	2909	4793	1.237	2.889	0.841 bc	1.173	0.928	1.862	0.096	0.178
	N2	0.983	0.429b	3.559	3.575	523	2036	2769	4711	1.268	2.931	0.848 bc	1.263	1.150	1.870	0.105	0.174
	TV-69E	1.320	0.485 b	3.740	3.668	703	1917	2889	4665	1.251	3.189	0.899 ab	1.144	1.228	1.926	0.099	0.178
10	Control	1.159	0.504 b	3.884	3.492	718	1616	3126	4337	1.374	2.967	0.859 bc	1.278	1.228	1.781	0.096	0.171
	TV-6I	1.011	0.588 b	3.787	3.453	380	1760	2913	4666	1.319	3.079	0.858 bc	1.128	1.189	2.121	0.115	0.182
	N2	1.032	0.485 b	3.840	3.192	524	1899	3078	4702	1.379	3.020	0.968 ab	1.283	1.017	2.004	0.097	0.182
	TV-69E	1.034	0.579 b	3.949	3.357	333	1694	2721	4446	1.295	3.189	0.888 ab	1.198	0.955	2.139	0.098	0.159
20	Control	1.107	0.597 b	3.902	3.573	409	1755	2773	4921	1.302	3.070	0.759 c	1.246	1.137	1.954	0.107	0.162
	TV-6I	1.279	1.093 a	3.928	3.808	465	2063	2750	4930	1.318	3.292	0.887 ab	1.152	1.046	2.060	0.092	0.165
	N2	1.171	0.812 ab	4.001	3.313	553	1962	3136	4711	1.413	3.345	0.930 ab	1.293	1.040	2.024	0.104	0.178
	TV-69E	1.256	0.551 b	3.959	3.884	443	1913	2879	4565	1.337	3.214	1.003 a	1.249	1.057	2.161	0.093	0.206
Averages of organic fertilizer	Control	1.053	0.495 B	3.699 B	3.394	518	1853	2771	4616	1.253 B	2.880 B	0.895	1.199	1.088	1.835 B	0.104	0.181
	10 ton ha^{-1}	1.059	0.539 B	3.865 AB	3.374	488	1742	2959	4538	1.342 A	3.078 AB	0.893	1.221	1.042	2.011 A	0.102	0.174
	20 ton ha^{-1}	1.204	0.763 A	3.948 A	3.636	467	1923	2885	4781	1.342 A	3.230 A	0.895	1.235	1.070	2.050 A	0.099	0.178
Averages of bacteria application	Control	1.015	0.557 B	3.772	3.454	487	1605 B	2806	4516	1.310	2.849 B	0.871	1.203	1.123	1.805 B	0.107	0.176
	TV-6I	1.140	0.725 A	3.893	3.420	451	1947 A	2858	4796	1.291	3.087 A	0.862	1.151	0.993	2.014 A	0.101	0.175
	N2	1.062	0.576 B	3.799	3.360	533	1966 A	2994	4708	1.353	3.099 A	0.915	1.280	1.069	1.966 A	0.1020	0.178
	TV-69E	1.203	0.538 B	3.883	3.637	493	1841 AB	2830	4559	1.310	3.215 A	0.930	1.197	1.080	2.075 A	0.097	0.181

*, %5; **, %1; ***, %0.1; ns, non significant; A, B, C; the difference between the averages indicated by the same letter is not significant

Table 5. Mean values of the bacteria and organic manure applications on the micro nutrients

Organic manure doses (ton ha^{-1})	Bacteria codes	Iron (mg kg^{-1})				Manganese (mg kg^{-1})				Zinc (mg kg^{-1})				Copper (mg kg^{-1})			
		Straw		Grain		Straw		Grain		Straw		Grain		Straw		Grain	
		2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11	2009-10	2010-11
Control	Control	486	233	40.0	46.0	37.0 bc	50.3	21.3	31.0	7.87	8.53	5.87 b	24.90	17.80 b	6.17	15.57 b	7.27
	TV-6I	372	301	40.0	43.0	31.7 c	60.0	26.7	29.3	5.6	6.07	11.50 a	22.77	9.30 c	5.73	9.00 c	6.83
	N2	635	247	38.3	44.3	45.7 abc	59.0	28.0	28.3	7.93	8.93	12.50 a	23.97	7.13 cd	5.70	8.4 cd	7.77
	TV-69E	780	267	39.7	48.3	58.3 a	68.3	29.3	32.7	10.0	9.67	12.43 a	23.33	6.43 cde	5.90	7.97 cde	7.10
10	Control	734	381	33.0	45.0	38.3 bc	71.3	24.7	32.7	8.57	10.67	10.77 a	24.23	23.33 a	6.87	16.23 b	8.04
	TV-6I	486	458	39.0	44.3	39.3 bc	77.7	29.7	31.0	7.90	12.10	11.63 a	21.33	7.17 cd	5.60	5.97 c-f	7.53
	N2	516	498	38.3	49.0	43.0 bc	81.3	27.7	37.3	9.10	11.07	12.17 a	24.97	4.30 de	5.77	5.23 def	8.43
	TV-69E	391	513	37.0	47.3	33.3 bc	74.7	28.3	31.0	8.67	9.27	11.20 a	21.93	4.53 de	5.10	4.50 f	7.00
20	Control	471	438	38.7	49.0	35.0 bc	61.7	25.7	31.0	6.97	10.10	11.00 a	23.33	25.80 a	6.37	21.57a	8.73
	TV-6I	558	589	36.3	47.0	41.3 bc	80.7	27.7	32.0	8.83	9.80	11.57 a	24.60	3.97 e	6.23	4.23 f	8.50
	N2	597	630	33.3	49.3	48.0 ab	65.0	24.7	32.0	9.47	9.80	12.80 a	23.83	5.13 de	6.30	5.20 def	8.47
	TV-69E	562	545	36.0	47.3	41.0 bc	59.7	25.0	30.3	7.30	9.47	12.10 a	21.57	4.13 de	5.57	4.70 ef	6.73
Averages of organic fertilizer	Control	568	262 C	39.5 A	45.4	43.2	59.4 B	26.3	30.3	7.85	8.30 B	10.58	23.71	10.17	5.86	10.24 A	7.24
	10 ton ha^{-1}	532	462 B	36.8 AB	46.4	38.5	76.3 A	27.6	33.0	8.56	10.78 A	11.44	23.09	9.81	5.83	7.98 B	7.84
	20 ton ha^{-1}	547	550 A	36.7 B	48.2	41.3	66.8 AB	25.8	31.3	8.14	9.79 AB	11.87	23.33	9.76	6.12	8.93 AB	8.10
Averages of bacteria application	Control	564	351 B	37.2	46.7	36.8 B	61.1	23.9 B	31.6	7.80	9.77	9.21 B	24.12	22.28 A	6.47 A	17.79 A	8.13 A
	TV-6I	472	449 AB	38.4	44.8	37.4 AB	72.8	28.0 A	30.8	7.44	9.32	11.57 A	22.90	6.81 B	5.86 AB	6.40 B	7.62 AB
	N2	583	458 A	36.7	47.6	45.6 A	68.4	26.8 AB	32.6	8.83	9.93	12.49 A	24.26	5.52 BC	5.92 AB	6.28 B	8.22 A
	TV-69E	578	442 AB	37.6	47.7	44.2 AB	67.6	27.6 AB	31.3	8.66	9.47	11.91 A	22.24	5.03 C	5.52 B	5.72 B	6.94 B

*, %5; **, %1; ***, %0.1; ns, non significant; A, B, C; the difference between the averages indicated by the same letter is not significant

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