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Evaluation agronomic traits of soybean affected by vermicompost and bacteria in sustainable agricultural system

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Abstract

Application of vermicompost and bacteria is a sustainable technology capable that improve plants growth, therefore a field experiment was conducted a split plot arranged in randomize complete block design in three replication, main plot consist of two level of bacteria (B1),(control) and (B2) and sub plot consist of three level of vermicompost, (V1),(control), (V2) and (V3), results of means comparison with Duncan's multiple range in($P \leq 0.05$)showed that highest seed yield and oil yield was observed from application of 10 ton vermicompost with 1699 kg/ha and 210.9 kg/ha respectively so application of bacteria had highest harvest index this positive effect was attributed to highest seed yield, in continuance highest protein content was observed from application of bacteria with 32 percent.

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Introduction

The long-term use of inorganic fertilizers without organic supplements damages the soil physical, chemical and biological properties and cause environmental pollution. Vermicompost are effective organic fertilizers and bio control agents that have organic nutrition role and increase plants growth(Arancon, 2005; Simsek, 2011). Application of vermicompost is a sustainable technology capable that improve plants growth and yield of them (Castillo *et al*., 2010). So Simsek (2011) concluded that vermicompost can improve food quality and safety. Applications of vermicompost singly or in combination with other organic fertilizer have been proved effective to enhance growth and yield of various plants like Soybean and other crops and yield of them increased (Javed, 2013). Fallahi *et al* (2008) concluded that several studies have reported that vermicompost can increase the growth and biomass of some medicinal plants such as chamomile. Some symbiotic N2 fixing *Rhizobium* strains not only fix atmospheric N2 in the nodules but also show an antagonistic effect against soil-borne pathogens (Ganesan *et al*., 2007). Saber *et al* (2009) found dual inoculation of faba bean seeds with a mixture of *R. leguminosarum* and followed by foliar spraying led to significant enhancements in number and dry weight of nodules and nitrogenase activity during the growth period. Organic manures act not only as a source of nutrients, but also increase size, biodiversity and activity of the microbial population in soil, influence structure, nutrients and many other changes related to physical, chemical and biological parameters of the soil (Albiach *et al*., 2000). Arancon *et al* (2005) reported vermicompost contain most nutrients in the available forms such as nitrates, phosphates, exchangeable calcium and soluble potassium that have vital role for plants. Studies carried out by Wasule *et al* (2007) clearly revealed that co-inoculation of *Bradyrhizobium* and phosphate microorganism significantly improved soybean growth and its yield components as compared with the sole application of *Bradyrhizobium* or phosphate microorganism. *Bradyrhizobium japonicum* is an important gram-negative bacterium that has the ability to form root nodules on soybeans and to fix atmospheric nitrogen and increase crop yield (Isawa *et al*.,1999). Lourduraj (2000) has also reported that the combined application of' inorganic and organic manures significantly enhanced the growth attributes and yield of soybean as compared to the sole application of either of them. The objectives of this research were to evaluated effects of vermicompost and *Bradyrhizobium Japonicum* bacteria on the growth and biomass of soybean and response of soybean to sustainable agriculture system.

Materials and methods

Site description

This study was carried out at the field research of Sanandaj, Iran located at (35˚ 16′ N latitude and 46˚ 29′ E longitude) with an altitude of 1393 m above sea during 2012-2013. This region has a semi-arid climate (350 mm annual rainfall). The soil texture of the experimental site is a sandy loam, with a pH of 7.5 and Ec=1.283 ($EC*10^4$) (using an Electrical Conductivity Meter) (Table1).

Experimental design

A field experiment was carried out a split plot arranged in randomized complete blocks design with three replications(in may 2012) main plots consisted of two level of bacteria non application (control) and application of bacteria and sub plot consist of three level of vermicompost, non application of vermicompost(control), application of 5 ton vermicompost in hectare and application of 10 ton vermicompost in hectare, so *Safiabad* cultivar was used for experiment , each sub plot was 6 m long and consisted of 6 rows, 50 cm apart with intra row spacing of 10cm to achieve the plant density of 20 plants/m2, land of experiment was plowed in autumn of previous year and in spring of experiment year was disked , With attention to annual rainfall mean, soil test and vermicompost analysis results(table1,2) application of vermicompost with attention to physiochemical test soil and vermicompost analysis was done. Evaluated traits consist of pod number per plant, harvest index, seed yield, oil content, oil yield and protein content . Protein content of seeds was

determined with Microkjeldhal method Bremner (1996) and estimation of oil content was extracted with petroleum ether using Soxhlet (AOAC, 1990).

Sampling

At maturity stage, 60 plants from each plot were randomly selected for the measurement of yield components. Harvested area was 6m × 3m in each plot. Seed yield of soybean was adjusted to 12% moisture content.

Statistical analysis

The data collected in this study were subjected to composed analysis of variance (ANOVA) using MSTAT-C, Version 1.41, Crop and Sciences Department, Michigan State University, and Duncan's multiple range in($P \leq 0.05$) used to compare means of traits.

Results and discussion

Pod number per plant

Regarding pod number per plant results showed that vermicompost treatment had significant effect in($p<5\%$) on pod number per plant (Table 3), so in means comparison of bacteria various levels application of bacteria had highest pod number per plant with 34 number and lowest of them was observed from non application of bacteria(table4). Soybean seed inoculation by *rhizobial* bacteria (Kazemi *et al.*, 2005) and *B. japonicum* bacteria (Zhang *et al.*, 2002) was also increased pods per plant. In vermicompost levels, non application of vermicompost had highest pod number per plant and lowest of them was observed from application of vermicompost. Interaction between application of bacteria × non application of vermicompost had highest pod number per plant.

Table 1. Result of physiochemical test soil.

Electrical conductivity (EC*104)	PH	Total nitrogen	Organic carbon	Clay (Percent)	Silt	Sand	Absorption potassium	Absorption phosphorus ppm)(
1.283	7.5	0.107	1.07	9.4	26	64.6	120	11.7

Table 2. Compounds of vermicompost.

	pH	N	P (%)	K	Ca	Mg	Zn (ppm)	S	Cu
Organic manure	6.45	0.99	0.59	0.51	735	1000	28	649	29

Table 3. Results of variance analysis traits under treatments effects.

		Mean square					
S.O.V	df	Pod number per plant	Harvest index	Seed yield	Oil content	Oil yield	Protein content
R	2	22.389^{ns}	41.056^{ns}	8448.22^{ns}	0.140^{ns}	256.97^{ns}	0.252^{ns}
B	1	46.722^{ns}	64.222^{ns}	172480.2ns	2.311^{*}	5854.8^{ns}	0.142^{ns}
Error	2	4.389^{ns}	48.389^{ns}	233798.2^{ns}	0.070^{ns}	2774.7^{ns}	1.587^{ns}
V	2	95.722^{*}	27.556^{ns}	220438.3^{*}	2.383^{**}	5952.7^{**}	2.122^{ns}
B× V	2	70.056^{ns}	262.889^{**}	72287.05^{ns}	8.683^{**}	68899.1^{**}	3.177^{ns}
Error	8	22.722^{ns}	25.899^{ns}	47164.5^{ns}	0.071^{ns}	393.743^{ns}	1.473^{ns}
C V(%)		15.74	21.40	13.10	2.56	11.35	3.80

ns, Non significant; * , Significant at the 5% of probability level(P< 0:05); **, Significant at the 1% of probability level (P < 0:01). B, Bactria; R, Replication; V, Vermicompost.

Harvest index

Results of means comparison with Duncan's multiple range in($P \leq 0.05$) in various vermicompost levels showed that highest harvest index was observed from application of five tone vermicompost and non application of vermicompost had lowest harvest index(Table4). Soleymani *et al* (2010) showed that cultivar had significant influence on seed yield, a thousand seed weight, oil percentage, oil yield, biological yield and harvest index. So harvest index is

one of the most important trait that affected seed yield , More fertilizer increased the harvest index due to more grains and the weight of 1000 grains in the plant. And in continuance results showed in bacteria levels application of bacteria had highest harvest index that showed importance of bacteria application.

In continuance results showed that interaction between bacteria × vermicompost had significant effect in ($p<1\%$) on harvest index and highest harvest index was observed from interaction of application bacteria × non application of vermicompost (Fig.1).

Table 4. Mean values of traits as influenced by treatments.

Treatment B	V	Pod number per plant (number)	Harvest index (percent)	Seed yield (kg/ha)	Oil content (percent)	Oil yield (kg/ha)	Protein content (percent)
B1		31b	22b	1443b	10a	156b	31b
B2		34a	26a	1636a	10a	192a	32a
	V1	39.50a	21.33a	1419a	10.47b	160.5b	32.56a
	V2	36.50a	25.33a	1502a	9.775c	153b	31.689a
	V3	36.67a	24.67a	1699a	11.03a	210.9a	31.579a
B×V							
B1×V1		24.33c	12b	1311a	11.17ab	171.8b	33.10a
B1×V2		34b	28.67a	1352a	9.667c	143.8b	30.77a
B1×V3		43.33ab	25a	1667a	9.367c	155.8b	31.77a
B2× V1		48.67a	30.67a	1526a	9.767c	149.1b	32.20a
B2× V2		39.33ab	22a	1652a	9.883c	163.3a	32.60a
B2× V3		11.02d	24.33a	1731a	12.70a	266.1a	31.37a

Different letters within each group of a column indicate significant differences at $P \leq 0.05$ according to Duncan's multiple range test. B1, Non application of bacteria; B2, Application of bacteria;V1, Non application of vermicompost;V2, Application of five ton vermicompost;V3, Application of ten ton vermicompost.

Seed yield

3Regarding seed yield showed that vermicompost had significant effect on seed yield in ($p<5\%$),(table3) and means comparison with Duncan's multiple range in($P \leq 0.05$) in various levels of vermicompost showed that highest seed yield was observed from application of ten tone vermicompost with 1699kg/ha and lowest was observed from non application of vermicompost with 1419 kg/ha(Table4). Increases in yields by vermicompost applications in okra, strawberry, eggplant, potato, cucumber cultivars, Abelmoschus esculentus, peppers, crossandra, lettuce, Amaranthus species were reported by Ansari and Kumar Sukhraj (2010), Singh *et al* (2008), Moraditochaee *et al* (2011), Alam *et al* (2007), Azarmi *et al* (2009), Vijaya and Seethalakshmi (2011), Arancon *et al* (2005), Gajalakshmi and Abbasi (2002), Papathanasiou *et al* (2012) and Uma and Malathi(2009) respectively. In continuance results showed that bacteria treatment application of bacteria had highest seed yield and non application of bacteria had lowest seed yield. In the field trials, single and dual N-fixing *B. subtilis* and P-solubilizing *B. megaterium* inoculations significantly increased pod number, seed yield and total biomass yield of chickpea compared with the control treatment, equal to or higher than N, P, and NP treatments (Elkoca *et al*., 2008). Interaction between application of bacteria×application of ten tone vermicompost had highest seed yield, this positive effect was attributed to indicate importance role of vermicompost and bacteria(Fig.2).

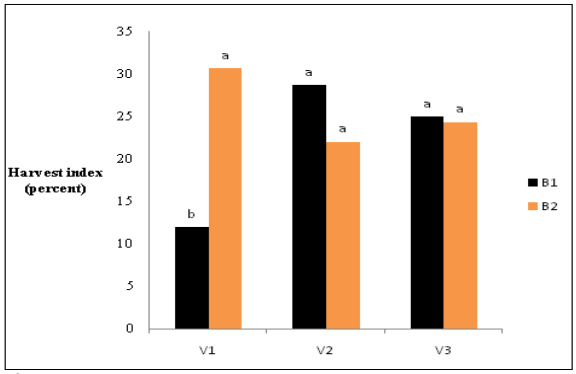

Fig. 1. Interaction effects of bacteria and vermicompost on harvest index.

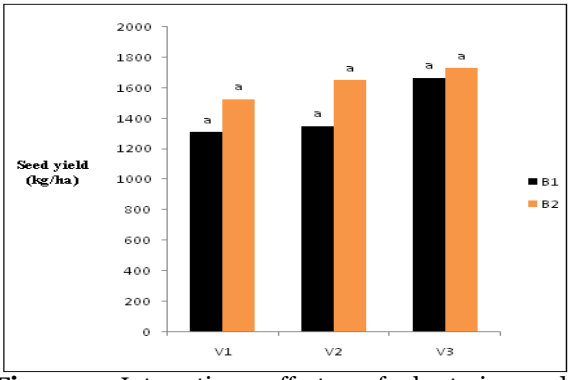

Fig. 2. Interaction effects of bacteria and vermicompost on seed yield.

Oil content

Oil content was significantly affected by bacteria, vermicompost and vermicompost× bacteria (Table3), thus result of means comparison with Duncan's multiple range in($P \leq 0.05$) showed that highest oil content was observed from application of ten tone vermicompost with 11.3 percent and application of five tone vermicompost with 9.7percent had lowest oil content(Table4). The oil and protein contents in soybean seed were strongly influenced by integrated nutrient management. Between various treatments, integration of 75% RDF with vermicompost at the rate of 1 t ha-1 and PSB produced significantly highest oil and protein content of soybean seed(Nandini Devi, 2013). In continuance result showed that interaction between non application of bacteria × Non application of vermicompost had highest oil content (Fig.3).

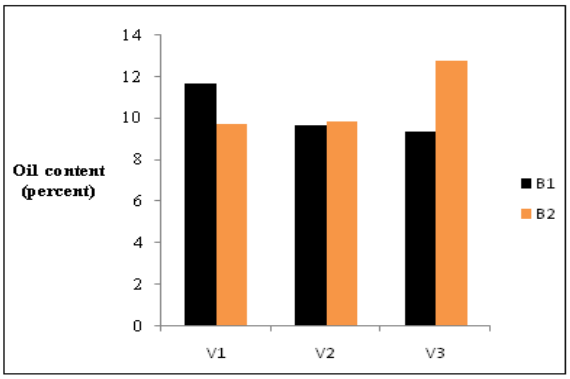

Fig. 3. Interaction effects of bacteria and vermicompost on oil content.

Oil yield

Oil yield was significantly affected by vermicompost and vermicompost× bacteria (Table3), thus result of means comparison with Duncan's multiple range in($P \leq 0.05$) showed that highest oil yield was observed from application of ten tone vermicompost with 210 kg/ha and application of five tone vermicompost with 153 kg/ha had lowest oil yield (Table4). The oil and protein contents in soybean seed were strongly influenced by integrated nutrient management. Havlin *et al* (1999) concluded that oil yield and protein yield were also observed in the same trend. The relative increase in oil yield by the integrated application of 75% RDF with vermicompost at the rate of 1 t ha-1 and PSB over control and 100% RDF were 260% and 63.64% respectively. Similarly, the increase in protein yield over control and 100% RDF were 209% and 58%, respectively. In continuance result showed that interaction between application of bacteria × applicaton of ten ton vermicompost had highest oil yield with 266 kg/ha (Fig.3).

Protein content

Result of means comparison with Duncan's multiple range in($P \leq 0.05$) showed that highest protein content was observed from application of bacteria with 32 percent(Table 4) and non application of bacteria with 31percent had lowest protein content that showed importance of bacteria. Protein contents in soybean seed were strongly influenced by cultivars and integrated nutrient management between various treatments that caused to received to highest protein yield(Havlin *et al.*, 1999). In all levels of vermicompost results showed that highest protein content was observed from non application of vermicompost and lowest of them was observed from application of ten tone of vermicompost.

Conclusion

In this research our results showed that agronomic traits were significantly affected by application of bacteria and vermicompost that showed importance of integrated nutrition system with vermicompost and bacteria.

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References

Abbasi MK, Manzoor M, Tahir MM. 2010. Efficiency of *Rhizobium* inoculation and P fertilization in enhancing Activities and Productivity of *Vicia faba*. Research Journal of Microbiology **4,** 286-300.

Al- Barrak KM. 2006. Irrigation interval and nitrogen level effects on growth and yield of rapeseed (Brassica napus L.). Scientific Journal of King Faisal University ,Basic and Applied Sciences **7,** 87-103.

Alam MN, Jahan MS, Ali MK, Ashraf MA, Islam MK. 2007. Effect of vermicompost and chemical fertilizers on growth, yield and yield components of potato in barind soils of Bangladesh. Journal Appled Science Research **3,** 1879–1888.

Albiach R, Canet R, Pomares F, Ingelmo F. 2000. Microbial biomass content and enzymatic activities after the application of organic amendments to a horticultural soil. Biores Technology **75,** 43-48. http://dx.doi.org/10.1016/S0960-8524(00)00030-4

Ali I, Ahmed H. M, Shah SA. 2013. Evaluation and selection of Rape seed (*Brassica napus* L.) mutant lins for the yield performance using Augmented desighn. Journal of Animal and Plant 23, 129-133.

Angadi SV, Cutforth HW , McConkey BG, Gan Y. 2003. Yield adjustment by rapeseed grown at different plant population under semiarid conditions. Crop Science **43,** 1358-1366.

Ansari AA, Kumar Sukhraj K. 2010. Effect of vermiwash and vermicompost on soil parameters and productivity of okra (*Abelmoschus esculentus*) in Guyana. African Journal of agriculture research **5,** 1794-1798.

AOAC. 1990. In: Helrich, K. (Ed.), Official Methods of
Analysis. , 15th ed. Association of Official Analytical Chemists, Arlington, VA/Washington, DC, USA.

Arancon NQ, Edwards CA, Bierman P, Metzger JD, Lucht C. 2005. Effects of vermicomposts produced from cattle manure, food waste and paper waste on the growth and yield of peppers in the field. Pedobiologia **49,** 297-306.

Arancon NQ, Edwards CA, Lee S, Byrne R. 2006. Effects of humic acids from vermicomposts on plant growth. European Journal of Soil Biology **42,** 65-69.

Atiyeh RM, Edwards CA, Metzer JD, Lee S, Arancon NQ. 2002. The influence of humic acids derived from earthworm-processed organic wastes on plant growth. Bioresour Technol **84,** 7–14.

Azarmi R, Giglou MT, Taleshmikail RD. 2009. Influence of vermicompost on soil chemical and physical properties in tomato *(Lycopersicum esculentum*) field. African Journal Biotechnol **7,** 2397–2401.

Bremner JM. 1996. Nitrogen-total. In: Sparks, D.K. (Ed.), Methods of Soil Analysis: Chemical Methods, Part 3. American Society of Agronomy, Madison, WI, 1085–1122 o.

Castillo JM, Nogales R, Romero E. 2010. Vermicomposts from agro industrial wastes and pesticides effects on soil microbial activity. Environmental and sanitary aspects of manure and organic residues utilization **6,** 1-4.

Chemical Methods, Part 3. American Society of Agronomy, Madison, WI, pp, Edwards CA, Arancon NQ. 2004. Vermicomposts suppress plant pest and disease attacks. Biocycle **45,** 51–55.

Elkoca E, Kantar F, Sahin F. 2008. Influence of nitrogen fixing and phosphorus solubilizing bacteria on the soybean. Biocycle **7,** 123-129.

Ercoli L, Lulli L, Mariotti M, Masoni A, Arduini I. 2008. Post-anthesis dry matter and nitrogen dynamics in durum wheat as affected by nitrogen supply and soil water availability. European Journal of Agronomy **28,** 138-147. http://dx.doi.org/10.1016/j.eja.2007.06.002

Fallahi J, Koocheki A, Rezvani Moghaddam P. 2008. Investigating the effects of organic fertilizer on quantity index and the amount essential oil and chamazulene in chamomile (*Matricariarecutita*). Agricultural Research. Water, Soil and Plant in Agriculture **1,** 157-168.

Fernández-Luqueño F, Reyes-Varela V, Martínez-Suárez C, Salomón-Hernández G, Yáñez-Meneses J,Ceballos-Ramírez JM, Dendooven L. 2010. Effect of different nitrogen sources on plant characteristics and yield of common bean (*Phaseolus vulgaris L.*). Bioresour Technology **1,** 396–403. http://dx.doi.org/10.1016/j.biortech.2009.07.058

Gajalakshmi S, Abbasi SA. 2002. Effect of the application of water hyacinthcompost vermicompost on the growth and flowering of Crossandra undulaefolia, and on several vegetables. Bioresour Technol 85,197–9. http://dx.doi.org/10.1016/S0960-8524(02)00096-2

Ganesan S, Ganesh kuppusamy R, Sekar R. 2007. Integrated Management of Stem Rot Disease Arachis hypogaeaL.Using Rhizobium and Trichoderma harzianum. Bioresour Technol **2,** 396–403.

Havlin LJ, Beaton DJ, Tisdale LS, Nelson LW .1999. Soil fertility and fertilizers. Published by Prentice- Hall of India Pvt. Limited, New Delhi, India, 6th edition **220(227 -228),** 319-346 o.

Isawa T,Sameshima R, Mitsui H, Minamisawa K. 1999. occurrence in *Bradyrhizobium japonicum* highly reiterated sequence-possessing strains with high copy numbers of repeated sequences *japonicum* strains allowing improved soybean yield in short-season. Agronomy Journal 94,870-875.

Javed S, Panwar A. 2013. Effect of biofertilizer, vermicompost and chemical fertilizer on different biochemical parameters of *Glycine max* and *Vigna mungo*. Recent Research in Science and Technology 5,40–44.

Kazemi S, Ghaleshi S, Ghanbari A, Kianoush GE. 2005. Effects of planting date and seed inoculation by the bacteria on the yield and yield components of two soybean varieties. Agriculture Science Nat Resource **12,** 20-26.

Lourdura JCA. 2000. Effect of irrigation and manure application on growth and yield of groundnut. Acta Agron Hungarica **48,** 83-88.

Moraditochaee M, Bozorgi HR, Halajisani N. 2011. Effects of Vermicompost Application and Nitrogen Fertilizer Rates on Fruit Yield and Several Attributes of Eggplant (*Solanum melongena L.*) in Iran. World Applied Sciences Journal **15,** 174–178.

Nandini Devi K, Basanta Singh T, Athokpam HS, Singh NB, Shamurailatpam D. 2013. Influence of inorganic, biological and organic manures on nodulation and yield of soybean (*Glycine max Merril L.*) and soil properties nodulation, plant growth, and yield of chickpea. Journal Plant Nutrition **31,** 157–171.

Papathanasiou F, Papadopoulos I, Tsakiris I, Tamoutsidis E. 2012. Vermicompost as a soil supplement to improve growth, yield and quality of lettuce (*Lactuca sativa L.*). Journal of Food, Agriculture Environment **10,** 677–682.

Saber WIA, Abd El-Hai KM, Ghoneem KM. 2009. Synergistic effect of *Trichoderma* and *Rhizobium* on Both Biocontrol of Chocolate Spot Disease and Induction of Nodulation, Physiological Activities and Productivity of *Vicia faba*. Research Journal of Microbiology **4,** 286-300.

Simsek-Ersahin Y. 2011. The Use of Vermicompost Products to Control Plant Diseases and Pests. In: Karaca A (ed) Biology of Earthworms, Soil Biology Springer-Verlag Berlin Heidelberg.

Singh R, Sharma RR, Kumar S, Gupta RK, Patil RT. 2008.Vermicompost substitution influences growth, physiological disorders, fruit yield and quality of strawberry Fragaria x ananassa Duch. Bioresour Technol **99,** 8507–8511.

Soleymani A, Shahri MM, Shahrajabian MH, Naranjani L. 2010. Responses of cultivars of canola to sulfur fertilizer and plant densities under climatic condition of Gorgan region, Iran. Journal of Food, Agriculture and Environment **8(3&4),** 298-304.

Uma B, Malathi M. 2009. Vermicompost as a soil supplement to improve growth and yield of Amaranthus species. Research Journal Agriculture Biology Science **5,** 1054–1060.

Vijaya KS, Seethalakshmi S .2011. Contribution of Parthenium vermicompost in altering growth, yield and quality of Alelmoschus esculentus (I) Moench. Advanced Biotech **11,** 44-47.

Wasule DL, Wadyalkar SR, Buldeo AN. 2007. Effect of Phosphate Solubilizing Bacteria on Role of *Rhizobium* on Nodulation by Soybean. In: First International Meeting on Microbial Phosphate Solubilization, Velazquez, E. and Rodriguez-Barrueco, C. 139-142 0.

Zarco-Tejada P, Miller JR, Mohammed GH, Noland TL, Sampson PH. 2002. Vegetationstress detection through chlorophyll a + b estimation and fluorescence effects on hyper spectra. Journal. Environ. Qual **31,** 1433–1.

Zhang H, Prithiviraj B, Charles TC, Driscoll B T, Smith DL. 2003. Low Temperature Tolerant *Bradyrhizobium japonicum* Strains Allowing Improved Nodulation and Nitrogen Fixation of Soybean in a Short Season (cool spring) Area. European Journal. Agronomy **19,** 205-213.