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INFLUENCE OF BACTERIA AND CHICKEN MANURE ON YIELD AND YIELD COMPONENTS OF BEAN (*Phaseolus vulgaris* L.)

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ABSTRACT

The effects of chicken manure and different bacteria applications on yield and yield components of beans were investigated in present study. The field experiment was conducted during the 2019 and 2020 at the experimental area of the Faculty of Agriculture, Eskisehir Osmangazi University, Eskisehir, Turkey. Experiment laid out as split plot based on randomized complete block design with three replications. Chicken manure (chicken manure $^{+}$ and chicken manure $^{-}$) were main plots and bacteria applications (control; traditional; rhizobia; phosphorus dissolving bacteria; traditional + rhizobia; traditional + phosphorus dissolving bacteria; rhizobia + phosphorus dissolving bacteria; traditional + rhizobia + phosphorus dissolving bacteria) were sub-plots. All of the investigated characters were higher in second year than first year except for harvest index and hundred seed weight due to especially June precipitation in second year. Grain yield increased from 1233 kg/ha to 3111 kg/ha in the second year of the experiment. Application of chicken manure positively affected important yield components, chlorophyll content and yield. Grain yield increased by approximately 5% with the application of chicken manure. In general, the application of bacteria alone or together has positively affected yield and yield components. The highest yield was obtained from traditional+rhizobia+phosphorus dissolving bacteria application. Grain yield in terms of bacterial applications varied between 1915 and 2488 kg/ha. Consequently, it was determined that the efficiency of bacteria increased with the application of chicken manure and positive results were obtained in yield and yield components of beans.

Keywords: PGPR, phosphate dissolving bacteria, poultry waste, rhizobia, sustainable agriculture

INTRODUCTION

Sustainable agriculture and increasing plant productivity depend on sufficient organic matter and plant nutrients in soil. In general, organic matter is poor in the agricultural lands of Turkey (Genctan, 2006). Microorganism activities are more intense where soils were rich organic matter. In addition, organic matter is helpful the penetration of precipitation into the soil. Thus, the plant benefits more from precipitation. Moreover, the plant benefits from the nutrients found in the lower layers of the soil with its deep roots. Organic fertilizers such as cattle, goat, chicken, pigeon, worm and moss manure play a major role in increasing the amount of organic matter in the soil and improving the structure of the soil.

Chemical fertilizers are used extensively in agricultural production areas in Turkey. Chemical fertilizers have caused soil salinity, deterioration of soil structure, accumulation of some elements in the soil. In addition, new alternatives have been sought due to their polluting effects on soil and water. Therefore, the use of organic fertilizers and biofertilizer has important the agricultural. Since people's interest in organically produced products has increased in recent years, the use of organic farming systems has also increased (Ozturk et al., 2012; Ozturk and Yildirim, 2013).

Poultry residues can cause environmental pollution and health problems. Poultry waste can be used as fertilizer due to its high macro and micronutrient content. (Tagoe et al., 2008). Chicken manure is an important source of macro and micro nutrients especially N, P, K, and S (Boyhan et al., 2010). Aplication of chicken manure improves soil physical properties. Chicken manure is an affordable fertilizer that farmers can easily access. It also maintains soil fertility and minimizes the risk of nutrient loss (Srivastava et al., 2012; Yohanne et al., 2013).

Rhizobia are the bacteria that form nitrogen-fixing nodules on legumes. If biological nitrogen fixation is used effectively, atmospheric nitrogen is fixed by Rhizobia bacteria, and as a result, agricultural production is possible with less nitrogen fertilizer. The use of less nitrogen fertilizer provides benefits both economically and ecologically.

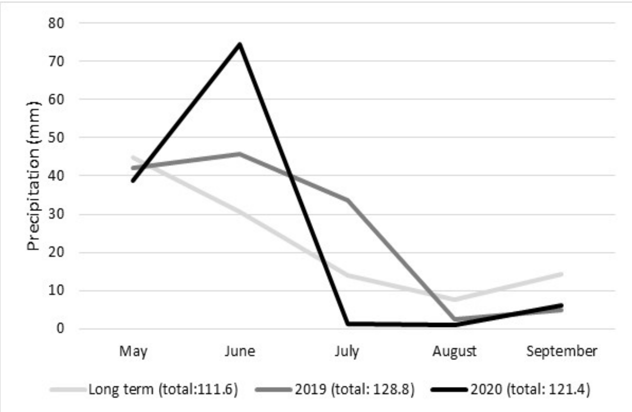
Bacteria that colonize the rhizosphere and plant roots and enhance plant growth by any mechanism are referred to as plant growth-promoting rhizobacteria (PGPR) (Ashrafuzzaman et al., 2009). PGPR are gaining importance as cost-effective, ecofriendly, non-hazardous, and non-toxic agri-inputs (Gupta et al., 2017). PGPR helps in crop well-being by fixing nitrogen, solubilising phosphate, producing phytohormones (like auxin, gibberellins, cytokinins etc.), reducing heavy metals, decomposing crop residue, mineralising soil organic matter, suppressing phytopathogens, etc. (He et al., 2019). Bacterial strains of genera *Acetobacter, Acinetobacter, Achromobacter, Aereobacter, Agrobacterium, Alcaligenes, Artrobacter, Azoarcus, Azospirillum, Azotobacter, Bacillus, Beijerinckia, Burkholderia, Clostridium, Enterobacter, Erwinia, Flavobacterium, Herbaspirillum, Klebsiella, Micrococcus, Paenibacillus. Pseudomonas. Rhizobium, Rhodobacter, Rhodosprilum, Serratia,* and *Xanthomonas* are the most widely accepted phosphorus solubilizing bacteria (PSB) (Cakmakci et al., 2006; Shahid et al., 2012).

Bacteria, which are dependent on soil organic matter as a nutrition source, increase their activities under favorable conditions and contribute to plant growth with nitrogen fixation, phosphate dissolving ability, and natural growth hormones. When organic matter is applied to the soil, an increase is observed in enzyme activities, microbial population, microbial activities and the number of phosphate solvent bacteria. Organic fertilizers, which are necessary for microbial development, are more effective than chemical fertilizers in terms of microbial population and microbial carbon. It is known that organic fertilizers cause changes in the microbial activity of the rhizosphere.

The aim of this study is to examine the effects of chicken manure and different bacteria applications on yield and yield components of beans in Eskisehir ecological conditions. It will be investigated the change in the efficiency of bacteria with the use of chicken manure in this study.

MATERIALS AND METHODS

The field experiment was conducted during the 2019 and 2020 at the experimental area of the Faculty of Agriculture, Eskisehir Osmangazi University, Eskisehir, Turkey (39°48' N; 30°31' E, 798 m above sea level). Figure 1 are shown long-term and experimental years climatic data. Total precipitation was 128.8 and 121.4 mm in the experimental years, respectively and long-term total precipitation was 111.6 mm. The annual average temperature was recorded as 19.82 °C in the first year and 20.78 °C in the second year. Soil samples of the research area were analyzed at the Transitional Zone Agricultural Research Institute (Anonymous, 2020). In the first year, the organic matter content was 1.65%, the lime was 7.56%, pH was 7.71, available P_2O_5, K_2O and N contents were 177.5 kg ha^{-1}, 2450 kg ha^{-1} and 0.08%, respectively. pH of 8.22, lime 6.73%, organic matter 1.19%, available P_2O_5 62.7 kg ha^{-1}, K_2O 3500 kg ha^{-1} and N 0.06% in the second year (Table 1). Experimental areas are slightly alkaline, low in organic matter, moderately calcareous, nitrogen is low and potassium is sufficient in both years. Phosphorus is sufficient in the first year and less in the second year (Alpaslan et al., 1998).



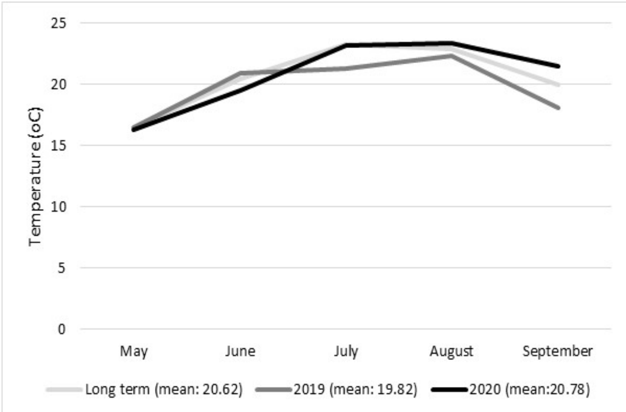


Figure 1. Climatic data of the research area

Table 1: Physical and chemical properties of the soils in the experimental years

Year	Depth (cm)	pH	Lime (%)	Organic matter (%)	N (%)	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
2019	0-30	7.71	7.56	1.65	0.08	177.5	2450
2020	0-30	8.22	6.73	1.19	0.06	62.7	3500

Experiment laid out as split plot based on randomized complete block design with three replications. Chicken manure (chicken manure $^{+}$ and chicken manure $^{-}$) were main plots and bacteria applications (control; traditional; rhizobia; phosphorus dissolving bacteria; traditional + rhizobia; traditional + phosphorus dissolving bacteria; rhizobia + phosphorus dissolving bacteria; traditional + rhizobia + phosphorus dissolving bacteria) were sub-plots. Bean varieties Topcu was used a genetic material. Rhizobia bacteria were obtained from Ankara Soil and Fertilizer Research Institute. Bontera commercial microbial fertilizer (*Bacillus amyloliquefaciens, Bacillus pumilus, Bacillus subtitles, Bacillus licheniformis, Bacillus megaterium, Trichoderma harzianum* and *Trichoderma konigii*) was used as the experimental phosphorus dissolving bacteria (P.D.B.). Chicken manure was obtained from Eskisehir Osmangazi University Faculty of Agriculture.

Rhizobia and P.D.B. were infected with bean seeds before sowing. The seeds were soaked with sugar water the bacteria to stick. Then, seeds were inoculated with 1 kg rhizobia bacteria to per 100 kg of seeds and 1-liter P.D.B. microbial fertilizer to per 100 kg of seeds. The seeds were dried in a shaded area and prepared for sowing. 10 tons ha^{-1} chicken manure was applied before sowing where chicken manure should be applied. Carnivorous chicken manure was used in the experiment. Each plot was 7.2 m^2 (4 m x 1.8 m) and bean was sown 45 cm row spacing and seeding rate was 26 seeds m^{-2}. The sowing time was 29 May and 21 May in 2019 and 2020, respectively. 140 kg ha^{-1} DAP (Diammonium phosphate 18-46-0) fertilizer was applied to the traditional fertilizer plots at sowing time. Weed control was done hand-weeding due to bacteria application. The experimental area was irrigated by sprinkler irrigation method when needed. The harvest was done by hand in the first year on 29.09.2019, and on 28.09.2020 in the second year.

Pod number per plant, seed number per plant and grain yield per plant (g) were evaluated on 5 randomly selected plants in each sub-plot. Each sub-plot was harvested, blended and biological yield (kg ha^{-1}), harvest index (%), hundred seed weight (g) and grain yield (kg ha^{-1}) were estimated (Tosun and Eser, 1978). Chlorophyll content were evaluated on 5 randomly selected plants in each plot with Spad 502 Plus chlorophyll meter. The leaf area was measured with a portable area meter Sunscan in the middle two rows.

The experiments were analyzed with the MSTATC statistical programs. Means were compared by Least Significant Differences (LSD) test (Steel and Torrie,1980).

RESULTS AND DISCUSSION

According to analysis of the variance, important yield components was statistically significant at year, chicken manure and bacteria aplications (Table 2). Pod number per plant, seed number per plant and grain yield per plant were higher in second year than first year. Especially June precipitation was higher, and temperature was more suitable in second year (Figure 1). Therefore, investigated charecters were higher in second year. Chicken manure application was increased pod number per plant, seed number per plant and grain yield per plant (Table 2). Chicken manure is an organic fertilizer rich in nutrients, especially nitrogen and phosphorus. It also improves the physical structure of the soil due to its organic matter content. Therefore, the soil becomes more suitable for plant growth (Adeleye et al., 2010). As a result, important yield components were higher. El-Bassiouny and Shukry (2001) found that the seed number per plant increased with the application of chicken manure in cowpea plants in Egyptian ecological conditions. Shalan (2005) achieved the higher grain yield per plant in chicken manure applications. The highest pod number per plant was observed traditional + rhizobia plots with 54.53. The highest seed number per plant and grain yield per plant were observed traditional plots with 178.26 and 49.43 g, respectively. However, these results are in the same statistical group as traditional + rhizobia applied plots. The lowest pod number per plant, seed number per plant and grain yield per plant were observed the control plots (Table 2). Traditional + rhizobia applications were affected positively important yield components. Phosphorus is sufficient in the soil of the research area in both years (Table 1). Therefore, the effect of phosphorus solvent bacteria may not have been observed. In addition, beans are warm season legumes. Phosphorus deficiency is more common in cold seasons. When the temperature increases, it becomes more soluble and useful (Connor et al., 2011). In this case, important yield components may not have responded to phosphorus solving bacteria. While the important yield components were low in the first year in traditional fertilizer applied plots, they were quite high in the second year (Figure 2 AB, 3A). It is well known that as the nutrient content increase in the soil, the response of plant to fertilizer decrease (Fageria et al., 2011; Connor et al., 2011). Available nitrogen, phosphorus and organic matter content are lower in the research area at the second year (Table 1). Therefore, the plants may have responded better to fertilization in the second year. Jarecki (2020) determined that the pod number per plant increased with the application of bacteria in the soybean plant. Jaipaul et al. (2011) reported that they obtained the highest pod number per plant in the application of NPK + microbial fertilizer + farm manure. Narayana et al. (2009) reported that the pod number per plant increased by 87% as a result of the application of chemical fertilizer + farm manure + microbial fertilizer in soybean. Singh et al. (2011) stated that bacterial applications gave positive results for seed number per plant. While pod number per plant, seed number per plant and grain yield per plant were lower in first year, same investigated characters were higher in second year. Therefore, year x chicken manure x application interactions were significantly (Figure 2AB, 3A).

According to analysis of the variance, biological yield was statistically significant at year, chicken manure and bacteria aplications (Table 2). Biological yield was higher in second year than first year. Especially June precipitation was higher, and temperature was more suitable in second year (Figure 1). Therefore, biological yield was higher in second year. Chicken manure application was increased biological yield (Table 2). Poultry feces are included high nitrogen. More nitrogen increases leaf growth and thus biomass increases (Arul, 2002). This result may be due to the fact that chicken manure encourages rapid growth and development of plants due to their nutrients. Singh and Rao (2009) reported that poultry fertilization significantly increased biomass. The highest biological yield was observed traditional + rhizobia + P.D.B. plots with 6825.0 kg ha^{-1}. These results are in the same statistical group as traditional applied plots. The lowest biological yield was observed the traditional + P.D.B. plots. Control, rhizobia and P.D.B. plots are in the same statistical group with traditional + P.D.B. plots (Table 2). Traditional + rhizobia + P.D.B. applications were affected positively biological yield. Phosphorus solvent bacteria did not increase the biological yield in both years due to sufficient phosphorus in the soil (Table 1). In addition, available phosphorus in the soil may have increased by increasing the solubility of phosphorus with the increase in temperature. While rhizobia + P.D.B. plots have lower value in first year, these plots showed higher value in second year (Figure 3B). Bacteria may have worked more effectively because of more suitable air due to lower precipitation. Genctan (2006) reported that soil temperature and air are very important for bacteria to be effective. Previous studies were reported that the biological yield was higher in the inorganic fertilization and bacterial inoculation compared to the control application (Dos Santos et al., 2017; MeCarty et al., 2017; Sood et al., 2018). While chicken manure^{-} and control plots showed the higher value in the second year, the same application showed lower values at chicken manure^{+} plots in first year. Therefore, year x chicken manure x application interactions were significantly (Figure 3B).

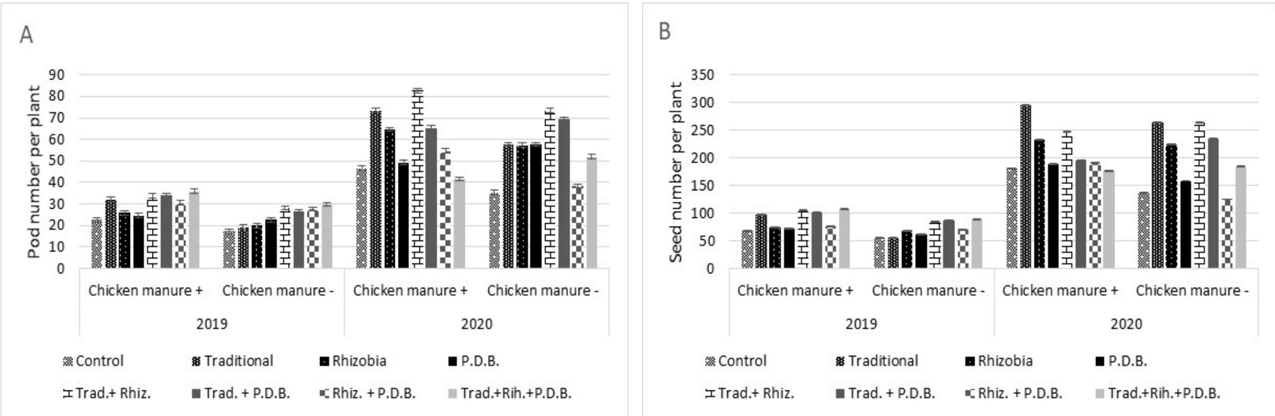


Figure 2. The interaction between year, chicken manure and application on pod number per plant (A) and seed number per plant (B) of bean.

According to analysis of the variance, grain yield was statistically significant at year, chicken manure and bacteria aplications (Table 2). Grain yield was higher in second year than first year. Especially june precipitation was higher and temperature was more suitable in second year (Figure 1). Therefore, grain yield was higher in second year. Chicken manure application was positively affected at grain yield. Tagoe et al. (2008) reported that chicken manure application increased yield. Inoculation with rhizobia bacteria did not affect the grain yield positively in the without chicken manure in the first and second years but rhizobia inoculation with chicken manure were obtained the highest results in the second year (Figure 3A). The use of chicken manure may have increased the amount and activity of rhizobia bacteria. Priya and Elekkiya (2012) reported that they obtained the highest yield from poultry fertilization and rhizobia application. The highest grain yield was observed traditional + rhizobia + P.D.B. plots with 2487.5 kg ha^{-1}. The lowest grain yield was observed the traditional + P.D.B. plots. P.D.B. plots are in the same statistical group with traditional + P.D.B. plots (Table 2). Phosphorus solvent bacteria did not increase the grain yield in both years due to sufficient phosphorus in the soil (Table 1). In addition, available phosphorus in the soil may have increased by increasing the solubility of phosphorus with the increase in temperature. Traditional + rhizobia + P.D.B. plots gave the highest grain yield in the first year of the study (Figure 4A). Bacteria may have worked more effectively because of more suitable air due to lower precipitation. Genctan (2006) reported that soil temperature and air are very important for bacteria to be effective. While chicken manure^{+} and rhizobia plots showed the highest value in the second year, the same application showed lowest values at chicken manure^{-} plots in first year. Therefore, year x chicken manure x application interactions were significantly (Figure 4A).

Table 2. Means of the measured traits

	Pod number per plant	Seed number per plant	Grain yield per plant (g)	Biological yield (kg ha^{-1})	Grain yield (kg ha^{-1})
2019	26.92 B	79.54 B	22.53 B	3354.5 B	1233.1B
2020	57.45 A	206.04 A	56.18 A	8899.7 A	3111.4A
Mean	**42.18**	**142.79**	**39.35**	**6127.1**	**2172.2**
Chicken manure $^{+}$	44.87 A	150.50 a	42.76 A	6214.3 A	2229.7 a
Chicken manure $^{-}$	39.50 B	135.07 b	35.94 B	6040.0 B	2114.7 b
Mean	**42.18**	**142.79**	**39.35**	**6127.1**	**2172.2**
Control	30.51 E	110.46 E	27.58 D	5736.6 C	2136.6 C
Traditional	45.60 BC	178.26 A	49.43 A	6794.1 A	2389.1 AB
Rhizobia	41.94 CD	149.50 B	36.17 C	5628.3 C	2091.6 C
P.D.B.	38.55 D	119.95 D	34.41 C	5706.6 C	1937.5 D
Trad. + Rhiz.	54.53 A	174.90 A	47.61 A	6383.3 B	2289.1 B
Trad. + P.D.B.	48.76 B	154.63 B	43.08 B	5588.3 C	1915.0 D
Rhiz. + P.D.B.	37.78 D	115.30 DE	35.47 C	6355.0 B	2131.6 C
Trad.+Rih.+ P.D.B.	39.83 D	139.33 C	41.08 B	6825.0 A	2487.5 A
Mean	**42.18**	**142.79**	**39.35**	**6127.1**	**2172.2**
General mean	42.18	142.79	39.35	6127.1	2172.2
Year	**	**	**	**	**
Chicken manure	**	*	**	**	*
Applicatons	**	**	**	**	**
Year x chicken m.	ns	ns	*	**	**
Year x applicat.	**	**	**	**	**
Chic. m.. x appl.	**	**	**	**	**
Yearx chic. m x appl.	**	**	**	**	**

ns: non significant, *: p≤0.05, **: p≤0.01.

According to analysis of the variance, harvest index was statistically significant at year and bacteria aplications (Table 3). Harvest index was higher in first year than second year. Vegetative development of plants was higher in the second year due to especially June precipitations. Therefore, the second year harvest index is lower. The highest harvest index was observed traditional + P.D.B. plots with 37.39%. However, these result is in the same statistical group as rhizobia plots (Table 3). Hridya et al. (2013) stated that the harvest index was higher with bacterial application compared to the control. Rhizobia and traditional + P.D.B. plots showed the highest values where chicken manure was applied in the second year (Figure 4B). Co-administration of chicken manure and bacteria had a positive effect on the harvest index. While chicken manure and rhizobia + P.D.B. applied plots showed the lowest value in the second year, the same application showed higher values in other plots. Therefore, year x chicken manure x application interactions were significantly (Figure 4B).

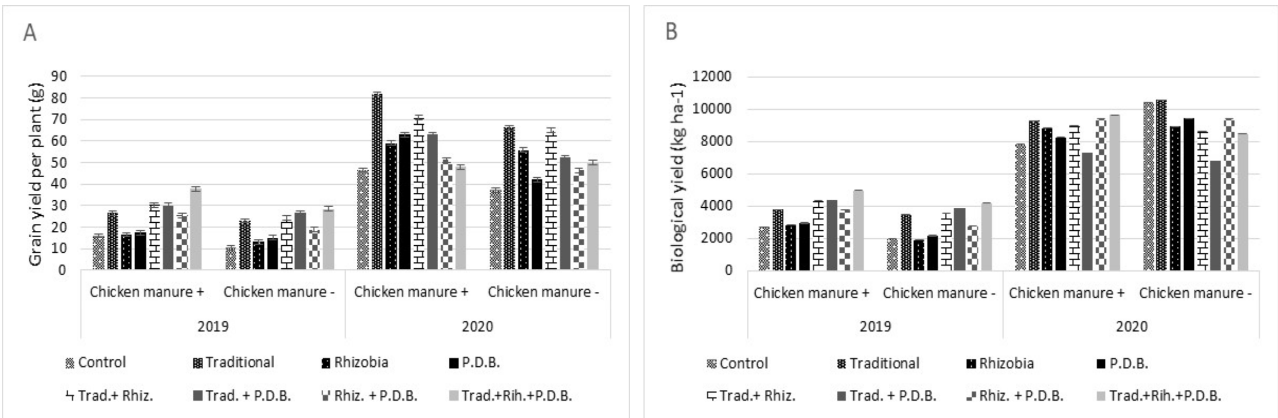


Figure 3. The interaction between year, chicken manure and application on grain yield per plant (A) and biological yield (B) of bean.

According to analysis of the variance, hundred seed weight was statistically significant at year and bacteria aplications (Table 3). Hundred seed weight was higher in first year than second year. The temperature is higher in second year than first year and long term (Figure 1). Anlarsal et al. (2000) reported that high temperature causes to be small and weak seeds in beans. Szilagyi (2003) reported that drought and high temperature reduced the hundred seed weight in beans. The highest hundred seed weight was observed traditional plots. However, these result is in the same statistical group as traditional + rhizobia plots (Table 3). The effect of phosphorus solvent bacteria may not have been observed due to sufficient phosphorus in the soil of the research area in both years (Table 1). In addition, phosphorus deficiency is more common in cold seasons. It becomes more soluble and useful in warm season (Connor et al., 2011). Beans are warm season legumes and therefore the effect of phosphorus solvent bacteria may not have been observed. Nagarjuna (2016) reported that bacteria applications positively affect the hundred seed weight. Rhizobia plots showed the highest values where chicken manure was applied in the first year (Figure 5A). Co-administration of chicken manure and bacteria had a positive effect on the hundred seed weight. While hundred seed weight was higher in first year, it was lower in second year. Therefore, year x chicken manure x application interactions were significantly (Figure 5A).

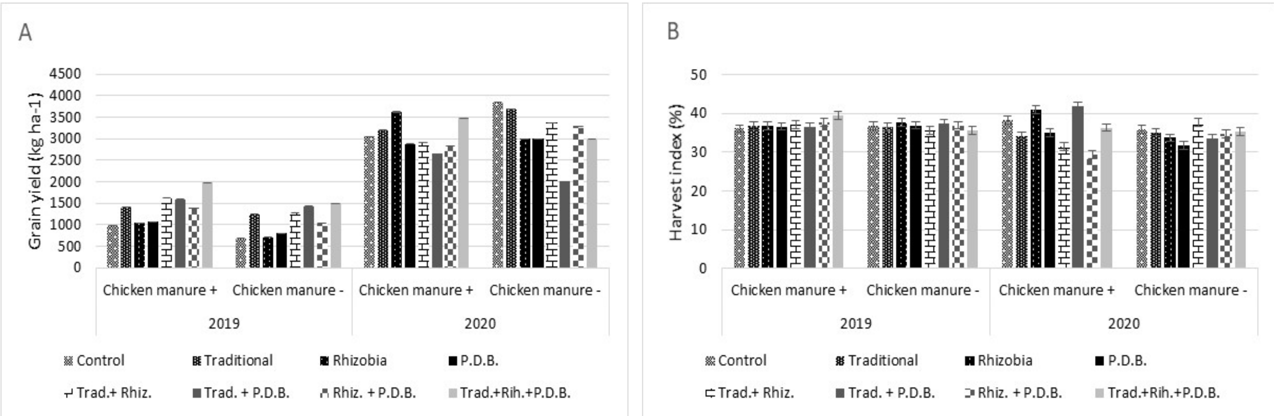


Figure 4. The interaction between year, chicken manure and application on grain yield (A) and harvest index (B) of bean.

According to analysis of the variance, chlorophyll content weight was statistically significant at year, chicken manure and bacteria aplications (Table 3). Chlorophyll content was higher in second year than first year. Especially june precipitation was higher and temperature was more suitable in second year (Figure 1). Yolcu (2014) reported that when there is more moisture in the root of the plant, the nitrogen in the soil is transmitted to the leaves through the xylem tissues and therefore chlorophyll content was increased. Chicken manure application was increased chlorophyll content (Table 3). Nitrogen is one of the essantial minerals for chlorophyll. Chicken manure is an organic fertilizer rich in nutrients, especially nitrogen and phosphorus. Increasing nutrient available in soil showed chlorophyll content increase. Argenta et al. (2003) reported that chlorophyll content increased when plants were adequately feed with nitrogen. Hosseinzadeh et al. (2016) stated that the application of vermicompost in chickpea cultivation had a positive effect on the chlorophyll content. While the highest chlorophyll content was observed traditional + P.D.B. plots, the lowest chlorophyll content was observed control plots. Bacteria application positively affected the chlorophyll content. Bacteria inoculation produced the higher chlorophyll contents, which may be related to increased chloroplasts in leaves (Rahimzadeh and Pirzad, 2017). Mahdavikia et al. (2019) reported that bacterial biofertilizer improved chlorophyll content. Rhizobia and P.D.B. plots showed the highest values where chicken manure was applied in the second year (Figure 5B). Co-administration of chicken manure and bacteria had a positive effect on the chlorophyll content. While chicken manure and rhizobia applied plots showed the highest value in the second year, the same application showed lower values in other plots. Therefore, year x chicken manure x application interactions were significantly (Figure 5B).

According to analysis of the variance, leaf area index weight was statistically significant at bacteria aplications (Table 3). The highest leaf area index was observed traditional + rhizobia + P.D.B. plots. The lowest leaf area index was observed the traditional + rhizobia plots. Traditional + P.D.B. plots are in the same statistical group with traditional + rhizobia plots (Table 3). Co-inoculation with rhizobia and P.D.B. were positive effected on leaf area index. Possibly, hormones secretion by bacteria, especially auxin, and continuous nitrogen fixation provide favorable conditions for increasing leaf area (Vahdatpour et al., 2021). Ju et al. (2019) reported that the amount of available nitrogen in the soil increased with rhizobia inoculation, and this had a positive effect on the plant. Kalayu (2019) reported that phosphorus is generally insoluble in the soil and is converted into a form that can be taken by plants with bacteria. Microbiological fertilizers play an important role in plant nutrition, development and yield. While the control plots showed highest values in the second year, the control plots showed very low values in the first year (Figure 6).

Especially June precipitation was higher in second year (Figure 1). Bacteria may have worked more effectively because of more suitable air due to lower precipitation in first year. Genctan (2006) reported that soil temperature and air are very important for bacteria to be effective. While chicken manure^{+} and control plots showed the highest value in the second year, the same application showed lowest values at chicken manure^{-} plots in first year. Therefore, year x chicken manure x application interactions were significantly (Figure 6).

Table 3. Means of the measured traits

	Harvest index (%)	Hundred seed weight (g)	Chlorophyll content (spad)	Leaf area index
2019	36.92 A	32.83 A	35.50 B	2.50
2020	35.38 B	25.03 B	45.00 A	3.28
Mean	**36.15**	**28.93**	**40.25**	**2.89**
Chicken manure $^{+}$	36.57	29.10	40.97 A	3.11
Chicken manure $^{-}$	35.73	28.77	39.53 B	2.66
Mean	**36.15**	**28.93**	**40.25**	**2.89**
Control	36.82 AB	29.13 ABC	35.40 D	3.02 AB
Traditional	35.69 BCD	29.62 A	41.38 B	2.82 AB
Rhizobia	37.29 A	28.87 ABC	40.18 BC	2.82 AB
P.D.B.	35.12 D	27.35 D	40.16 BC	3.05 AB
Trad. + Rhiz.	35.51 CD	29.56 A	40.55 B	2.58 B
Trad. + P.D.B.	37.39 A	28.70 C	44.70 A	2.59 B
Rhiz. + P.D.B.	34.73 D	28.76 BC	37.06 CD	2.84 AB
Trad.+Rih.+ P.D.B.	36.67 ABC	29.49 AB	42.58AB	3.38 A
Mean	**36.15**	**28.93**	**40.25**	**2.89**
General mean	36.15	28.93	40.25	2.89
Year	**	**	**	ns
Chicken manure	ns	ns	**	ns
Applicatons	**	**	**	**
Year x chicken m.	ns	ns	**	ns
Year x applicat.	**	**	**	**
Chic. m.. x appl.	**	**	**	ns
Yearx chic. m x appl.	**	**	**	*

ns: non significant, *: p≤0.05, **: p≤0.01.

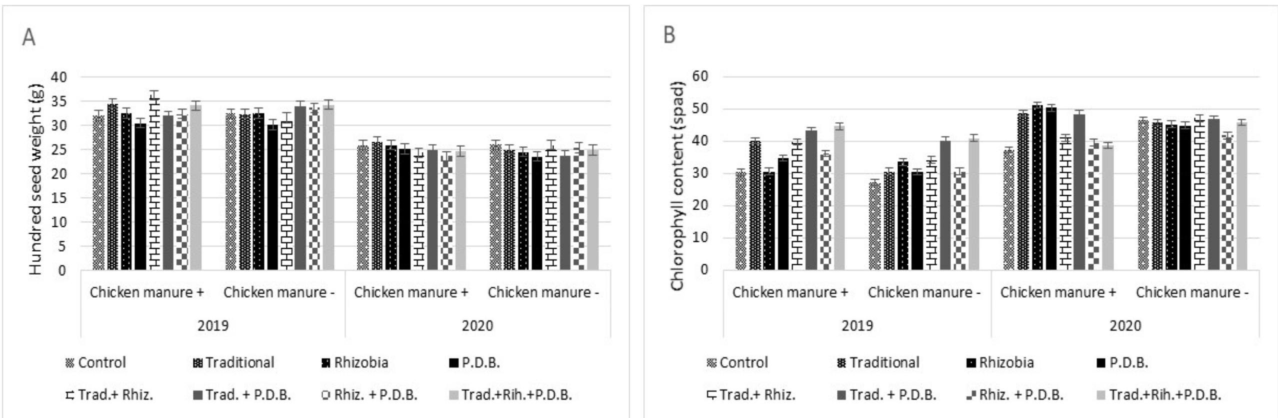


Figure 5. The interaction between year, chicken manure and application on hundred seed weight (A) and chlorophyll content (B) of bean.

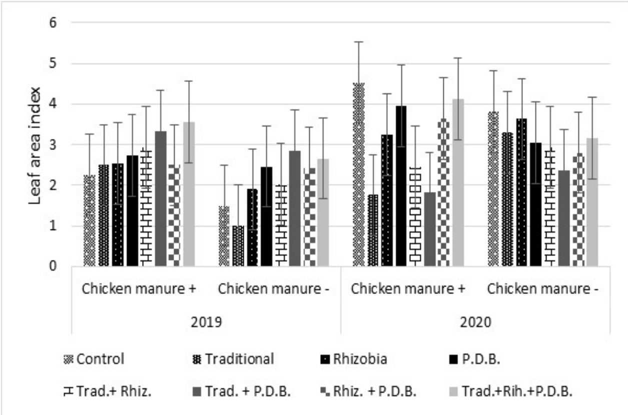


Figure 6. The interaction between year, chicken manure and application on leaf area index of bean.

CONCLUSIONS

All the investigated characters were higher in second year than first year except for harvest index and hundred seed weight due to especially June precipitation in second year. Application of chicken manure positively affected important yield components, chlorophyll content and yield. Chicken manure provides high levels of nutrients to the plant and increases bacterial activity and number. For this reason, there has been an increase where chicken manure is applied. In general, the application of bacteria alone or together has positively affected yield and yield components. The highest yield was obtained from traditional + rhizobia + P.D.B. application. Organic fertilizers, which are necessary for microbial development, are more effective than chemical fertilizers in terms of microbial population and microbial carbon. It is known that organic fertilizers cause changes in the microbial activity of the rhizosphere. Consequently, it was determined that the efficiency of bacteria increased with the application of chicken manure and positive results were obtained in yield and yield components of beans.

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