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The effect of the combined chemical, bio and vermicomposting fertilizers on yield and yield components of Vicia faba L.

Kamran Mansoorghanaie Pashaki*, Gholam Reza Mohsenabadi, Haddad Boroumand, Majid Majidian
Department of Agronomy and Plant Breeding, Faculty of Agriculture, University of Guilan
*E-mail: mansourghanaei_kamran@yahoo.com

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Abstract

In order to evaluate the effect of combined of chemical, bio and vermicomposting fertilizers on faba bean yield in Gilan province, a factorial experiment in a randomized complete block design with three replications was conducted in the city of Rasht in 2013. Treatments nitrogen fertilizer in three levels (zero, 50 and 100 kg per hectare), phosphorus fertilizer in three levels (zero, 50 and 100 kg per hectare), bio-fertilizer combination of Bacillus and Pseudomonas and without application of vermicomposting with two levels including Zero and 7 tons per hectare were considered for the study. The results showed that grain protein percentage was significantly affected by the interaction of nitrogen fertilizers × phosphor × vermicomposting× organic fertilizer and other traits affected by the interaction of biological nitrogen ×fertilizer × phosphorus and nitrogen. Means comparison showed that 100 kg of nitrogen per hectare, 100 kg phosphorus with the use of bio-fertilizer and vermicomposting increased grain yield and yield components. The seed yield of 100 kg N ha interaction was the highest in 100 kg of phosphorus per hectare (6243 kg/h) and the lowest in control (507 kg/h). Also, in interaction at phosphorus fertilizer bio-fertilizer, the seed yield of 100 kg of phosphorus by using bio-fertilizer (5497 kg/h) was observed and the interaction N × vermicomposting was observed at the highest grain yield at 100 kg nitrogen by the use of vermicomposting (5455 kg/h). The highest amounts of protein in treatment were in 100 kg N, 100 kg of phosphorus fertilizer with organic fertilizer usage and application of vermicomposting 7 tons per hectare (31.43 percent). In general, the results can be expected that the use of bio-fertilizers and vermicomposting can provide part of the required plant food.

Keywords: Faba Bean, Nutrient Uptake, Biological and Chemical Fertilizers, Vermicomposting

Introduction

Human needs energy on average about 2,800 calories daily, but in most advanced countries it 3,500 calories a day and in less developed countries and underdeveloped in about 2,200 calories for each individual. Bean, as one of the richest sources of vegetable protein and cereals are the second most important source of food for humans. (Majnoon Hosseini 1993, Parsa and Bagheri 1999) Amount of proteins in beans, is 2 to 3 times cereal and tuber plants is 10 to 20 times. (Bagheri et al. 2001)

Plant Nutrition is an important factor in improving the quantity and quality of all agricultural products in general. In the process of feeding not only have enough of each element available to plants, but also in terms of balance and proportionality between all the elements needed to plant the element of utmost importance. (Parsa and Bagheri 2008) Nowadays to feed the plants, large amounts of nitrogen and phosphate fertilizers used in addition to environmental degradation is dangerous to humans.

In this regard, fertilizers and bio-availability of nutrients for plants play an important role in sustainable agriculture. The bacteria in the bio-fertilizers increases the absorption of nutrients, the bacteria synthesize vitamins and amino acids also increase growth and product quality and through different processes can cause systemic resistance in plants against environmental stresses such as lack of ventilation, contamination by heavy metals, salinity, drought, pests and diseases. (Cantal et al. 2007)

Research has shown that the use of phosphate solubilizing bacteria increased germination, uptake, plant height, node number, total biomass and function and also nitrogen-fixing bacteria fixing molecular nitrogen through symbiosis with the roots of the plant, are siderophore production and acetic acid. (Rodriguez and Ferava in 1999, Rodersh et al. 2005)

Investigation showed that improper use of nitrogen and phosphorus fertilizers in field conditions is one of the factors limiting the performance of faba bean, (Hashemabadi 2013) followed by the use of phosphate solubilizing bacteria, nitrogen-fixing and vermicomposting as organic fertilizers to increase production and maintain soil health in the world is increasing.

Studies have shown that the combined application of vermicomposting organic fertilizers in the cultivation (rice - legumes) increased grain yield in both plants. (Jyabal and Kvpvsvamy 2000) Libon and colleagues (2001) reported that tests on bean plants increased use of vermicomposting positive and significant effects on plant dry weight, root to shoot ratio, the number of flowers per plant and an increase in nitrogen, phosphorus and potassium in the soil, as well as pest infestation of Vicia faba fell 71.3 to 64 per cent.

Jaat and Ahlawat (2006) reported that the use of Phosphate Solubilizing Bacteria and one strain of Rhizobium bacteria in combination with vermicomposting in pea plants increased the biological yield, grain yield and grain protein levels compared to the control. Olivera et al (2002) reported that Phosphate Solubilizing Bacteria and Rhizobium inoculation Japonicom increased positive effect on shoot dry weight, number of nodes and nitrogen fixation in Vicia faba.

Due to the increase in world population and the increasing need to provide food and on the other hand increase the production of healthy and organic products and replacement bio-fertilizers instead of chemical fertilizers, experiments to study the combined application of chemical fertilizer, biological and vermicomposting on growth and nutrient uptake faba bean was designed and implemented.

Materials and methods

This season tests implemented in 2013 on private farm, in the city of Saravan geographical location of 37 degrees and 4 minutes north latitude and 49 degrees 39 minutes east longitude. This experiment, factorial in a randomized complete block design with three replications was conducted in an area of 1,000 square meters.

The treatments included nitrogen and phosphorus fertilizer according to soil test super phosphate (Table 1) each at three levels (100 and 50 kg ha without fertilizer as control) vermicomposting at two levels (seven tons per hectare, without the use of vermicomposting) and Bacillus subtilis and Pseudomonas putida biological fertilizer at two levels (applied without the use of bio-fertilizer and bio-fertilizer) were the seed treatment method (Svmasgaran, 1994)

Furrow planting density of 15 plants per square meter spacing between rows 50 cm and 14 cm row plots of the size 2.5 × 4 cm was used. The distance between the repetition of a meter and the distance between plots was considered a Row Planting. Faba bean seeds used were obtained from the city of Rasht. After disinfection of seeds with fungicides Vitawax than two per thousand, planting operations on 15 November was five centimeters deep grooves. Control weeds by hand weeding was done at different growth stages.

Table 1: The soil characteristics of the test site

Potassium (mg.kg-1)	Phosphorus (mg.kg-1)	Total nitrogen (%)	Electric (dS.m-1)	Acidity (pH)	Organic carbon(%)	soil pattern
205	4.7	0.07	0.66	7.25	0.86	Clay loam

At the end of the growing season and after seeing signs of maturity and color of 75% of pods per plant and eliminating a marginal effect in each plot, five randomly selected plants and plant height and first pod height, number of pods per plant and seeds per pod were measured. Shoot dry weight, dry weight of seeds per plant and seed weight per plant harvested from an area of one square meter of intermediate plants per plot was determined.

To measure the biological yield, grain yield and harvest an area of two square meters per plot, grain weight and moisture content determination and seed yield values based on humidity 13% (Equation 1) and biological yield and harvest index, based on a moisture content of about zero using (Equation 2) was determined for each treatment. (AL-refaee 2004)

HI = Economic performance / biologic performance * 100 (1)

Performance = seed weight with humidity * (100 – seed humidity) / 100-13 (2)

To measure the amount of protein (Bradford, 1976) seed, a total number of 50 seeds from each plot with electric mill powder 30 mesh sieve and lived to be as a powder and then measured its protein content.

In this study, analysis of variance and comparison of software SAS Version 9.2 (2002SAS,) and for computing the correlation coefficient using SPSS version 16 (2007SPSS,) was used. Statistical comparison using Tukey test at level one and five percent.

Results and discussion

Number of pods per plant

Analysis of variance showed that the effect of nitrogen fertilizer, phosphorus fertilizer, bio-fertilizer, vermicomposting, the interaction of nitrogen fertilizers × phosphorus, nitrogen × bio-fertilizer, bio-fertilizer and nitrogen × phosphor × nitrogen × phosphor× one percent level vermicomposting and nitrogen interactions × vermicomposting at the level of five per cent on the number of pods per plant were significant. (Table 2)

Interaction of N × phosphor × average data on bio-fertilizer showed that the highest number of pods per plant per treatment 100 kg N, 100 kg phosphorus and organic fertilizer (9.55) and the lowest number of pods per plant in the treatment without the use of chemical fertilizers and biological control treatment (5.33). (Table 5)

Also on the Interaction of N × phosphor × vermicomposting highest number of pods per treatment 100 kg nitrogen, phosphorus and 100 kg of vermicomposting (8.46) showed that the treatment was not significantly different without the use of vermicomposting and lowest in the treatment without chemical fertilizers and vermicomposting (control) (5.43) showed that the treatment without nitrogen, 50 kg phosphorus and without the use of vermicomposting showed no significant difference. (Table 6)

Kumar et al. (2005) stated that the use of biological fertilizers with low rates of chemical fertilizers on sesame significantly increased the number of capsules per plant and seed yield. Taylor and Smith (1992) reported that increasing nitrogen up to 200 kg N ha significantly increased the number of pods per plant was rape. If the amount of nitrogen is much less favorable for plant growth and nitrogen removed from mature leaves and young parts transmitted, in this case nitrogen deficiency symptoms such as accelerated aging can be seen in older leaves.

Table 2: Analysis of variance values faba bean yield in manure nitrogen, phosphorus, organic manure and vermicomposting

Average of measured square								
Percent of protein	Harvest index	Seed performance	Seed weight	Shoot dry weight	The number of seeds per pod	Number of seed per	Freedom degree	Changing resource
2.27**	19.89**	4.00ns	10.09**	0.27ns	0.27ns	0.005ns	2	Block
2221.80**	7374.72**	17144.80**	2943.21**	57.95**	57.95**	88.26**	2	Nitrogen fertilizers
25.06**	580.19**	1403.93**	1900.71**	10.17**	10.17**	18.74**	2	Phosphorus fertilizers
151.11**	79.20**	517.32**	761.61**	4.32**	4.32**	4.56**	1	Bio-fertilizer
108.20**	24.43**	26.10*	215.84**	1.92**	1.92**	1.24**	1	Vermicompost
2.19**	7.92**	75.92**	99.20**	2.05**	2.05**	3.10**	4	N × phosphorus
0.63ns	1.66ns	28.35**	18.31**	0.75*	0.75*	0.23**	2	N × biofertilizers
1.62**	0.47ns	126.44**	0.60ns	0.36ns	0.36ns	0.04*	2	N × vermicompost
9.79**	0.42ns	5.50ns	5.76**	0.18ns	0.18ns	0.02ns	2	× phosphorus fertilizer bio-fertilizer
0.02ns	0.58ns	5.58ns	0.45ns	0.31ns	0.31ns	0.004ns	2	× phosphorus fertilizer vermicompost
2.53**	5.13ns	2.98ns	5.66*	0.23ns	0.23ns	0.005ns	1	Bio-fertilizer × vermicompost
2.35**	5.00ns	2.04ns	4.59**	0.32ns	0.32ns	0.13**	4	P × N × fertilizer bio-fertilizer
0.02ns	2.60ns	4.74ns	2.54*	0.25ns	0.25ns	0.03**	4	P × N × fertilizer vermicompost
1.46**	0.44ns	0.21ns	1.08ns	0.23ns	0.23ns	0.002ns	2	P × vermicompost fertilizer×, bio-fertilizer
0.14ns	0.46ns	0.85ns	0.65ns	0.19ns	0.19ns	0.02ns	2	N × vermicompost × organic fertilizer
0.56*	0.34ns	4.24ns	1.08ns	0.19ns	0.19ns	0.005ns	4	Bio-fertilizer ×phosphorus fertilizer ×N × vermicompost
0.20	2.02	4.49	1.00	0.44	0.21	0.008	70	Experimental error
-	-	-	-	-	-	-	107	Total
2.34	13.16	19.06	12.79	16.73	9.26	13.27	-	Coefficient of variation

Sn, * and ** non-significant, significant at 5% and 1%, respectively.

Increase the amount of this element not only delay the aging and growth, but also the specific case, the deformation of the appearance of the plant as well. (Taylor and Smith 1992) Argau (2012) Effect of Inoculation with Rhizobium and Pseudomonas be seen in Seville that the number of pods per plant inoculation with Rhizobium and Pseudomonas significantly increased compared with non-inoculated treatments.

Forzana and Radyza (2005) also reported that the combined application of chemical fertilizers, bio and application of vermicomposting balance between the reservoir and the source, so that tank capacity has been increased phosphorus and other nutrients, including phosphorus supply through the integrated application of fertilizers increases the strength of the source. (Increased rate of assimilation) (Jaat and Ahlawat 2004)

The number of seeds per pod

Based on results from the maximum number of seeds per pod average data vermicomposting treatment of 7 tons per hectare (5.09) (Figure 1) and the lowest in the treatment without fertilizer (4.82), respectively. In interaction N × phosphorus, nitrogen greatest number of seeds per pod at 50kg, 100 kg of phosphorus (6.46) (Figure 2) and the lowest number of seeds per pod in the treatment without the use of chemical fertilizers (control) (3.34) was observed.

Also in the interaction N × Bio fertilizer, the largest number of seeds per pod in the treatment of 100 kg nitrogen fertilizer with bio (6.03) (Figure 3) was observed. Reducing the amount of nitrogen increased abscission of flowers, fertility reduction goals and reduce the number of pods per plant, Therefore, to consume because of increased nitrogen fertilization and production of substances photosynthetic flowering period and further increases the number of seeds per pod. (Ratk 2004, Lymvnvrtga et al. 2006)

It was reported that the effects of phosphate solubilizing bacteria as bio fertilizers and phosphorus on yield and yield components of soybean was significant, and the maximum number of seeds per pod, and 100 kg phosphorus per hectare per consumption under this interaction effect of both bacterial strains were obtained (Yasari .2013) present the results of this study were consistent with experimental observations.

Karimi et al (2013) examined the effect of arbuscular mycorrhizal fungi on bio-fertilizers and Phaseolus vulgaris (Phaseolus vulgaris L) and Stated that the number of seeds per pod was a significant difference between treatments, and the largest number of seeds per pod in treatments with vermicomposting organic fertilizers were used.

Biological and vermicomposting in various ways such as changes in root morphology and secretion of hormones by slowing the growth of microorganisms and pathogens are increasing the length of the sheath. (Jaat and Ahlawat 2006, Kyzylkaya 2008) Study results showed that the number of seeds per pod correlation with shoot dry weight (** 0.928), seed weight (** 0.909) and HI (** 0.912) and a significant positive correlation a. (Table 3)

Seed weight

Greatest amount of seed weight in the interaction of phosphorus × N × fertilizer bio-fertilizer treatment 100 kg N, 100 kg phosphorus with the use of bio-fertilizers (146.47 grams) and minimum on treatment without the use of chemical fertilizers and organic manure (treatment control) (104.57 g), respectively. (Table 5) Also highest proportion of seed weight in the interaction N × phosphorus × vermicomposting fertilizer treated with 100 kg N, 100 kg phosphorus ha with seven tons of vermicomposting (146.46 mg) was observed (Table 6)

Hundred seeds weight is directly influenced by the photosynthetic material after it is pollinated, the plant material of current photosynthesis or remobilization can be stored in the stems, leaves or pods are provided. (Ahmadi & Bahrani .2009) Hundred seeds with an increased weight gain during seed filling period had been accounted for and can show the effect of photosynthetic bacteria, enhancing plant growth by increasing the amount of material stored in the grain filling period. (Akbari et al. 2009)

The use of bio-fertilizer and seed inoculated with bacteria as well as the use of vermicomposting, the biological nitrogen, root, optimal absorption of water and nutrients and produce some vitamins increases followed by qualitative and quantitative growth of the plant and thereby strengthen weight gain will be determined for hundred seeds. (Kumar et al. 2005, Rossetti et al. 2006)

Seed yield

Statistical analysis showed that treatments such as nitrogen, phosphorus fertilizer, bio-fertilizer, the interaction of N × phosphorus fertilizer, N and bio-fertilizer × N × vermicomposting significant effect on the likelihood of a significant effect of treatment vermicomposting the grain yield was significant at the level of five percent. (Table 2)

Results showed that the average data at N × treatment interaction phosphorus fertilizer, grain yield maximum amount of 100 kg and 100 kg of nitrogen, phosphorus (6243 kg/h) and minimum on treatment without the use of chemical fertilizers (507 kg/h) was observed. (Figure 7)

Also the results showed that the treatment of the interaction N × 100 kg of nitrogen fertilizer, bio-organic fertilizer with Greatest amount of Seed yield (5497 kg/h), and treatment without nitrogen and organic fertilizers and grain yield (807 kg/h) is allocated. (Figure 8) Interaction of N × vermicomposting also the highest yield of 100 kg nitrogen treatment and use 7 tonnes of vermicomposting (5455 kg/h) and lowest in treatment without nitrogen and vermicomposting (1111 kg/h) was obtained. (Fig. 9

Some researchers believe that the application of nitrogen fertilizer due to the increased efficiency of photosynthesis per unit area will lead to an increase Seed yield. (Shima et al. 2001) Some others believe that consuming higher amounts of nitrogen fertilizer increased the number of pods per plant and thus improve performance. (Wright et al, 1988; Gupta et al. 2002)

It is reported that concomitant use of nitrogen fixing and vermicomposting increased barley yield, Also, from combination of phosphorus bacteria and the fungus Aspergillus highest grain yield was obtained with inorganic phosphate. They believe that increasing the absorption of minerals in the soil enhanced by biological factors and increased dry matter yield. (Blymvv et al. 1995, 2006 Babana and Anton, Roya and Sin 2006)

Table 3: Correlation between yield and yield components of beans in manure nitrogen, phosphorus, organic manure and vermicomposting

Features	1q	2	3	4	5	6	7	8	9	10
1	1.00									
2	0.980**	1.00								
3	0.975**	0.988**	1.00							
4	0.887**	0.916**	0.928**	1.00						
5	0.918**	0.888**	0.909**	0.839**	1.00					
6	0.869**	0.823**	0.826**	0.751**	0.927**	1.00				
7	0.947**	0.933**	0.912**	0.828**	0.843**	0.870**	1.00			
8	0.924**	0.970**	0.943**	0.894**	0.825**	0.791**	0.899**	1.00		
9	0.889**	0.886**	0.863**	0.790**	0.791**	0.812**	0.953**	0.860**	1.00	
10	-0.859**	-0.876**	-0.854**	-0.758**	-0.779**	-0.761**	-0.888**	-0.872**	-0.931**	1.00

The effects of cross-fertilization of sorghum seeds with a combination of Bacillus bacteria, Srayta, Pseudomonas and G. mosseae fungi. 45 days after planting, showed that the combination of three breed bacteria and mycorrhizal fungi plant growth by 17 to 20 percent. (Rasi Poor and Asghar Zadeh. 2007)

In a study of the effects of inoculation with nitrogen-fixing plants (Nitrogenouebacteria) and phosphate solubilizing bacteria (Pseudomonas and Aspergillus) in vermicomposting, it was observed that food consumption by plants and microorganisms increases were a result of increased performance (Ardakani and et al. 2001, Khavazi and Malakouti,2001) Correlation analysis showed a significant positive correlation between grain yield and number of pods per plant (** r= 0.823), the number of seeds per pod (** r= 0.826) and hundred seeds weight (** r= 0.927) there. (Table 3)

q1. Plant height
2. Height of the first pod
3. Number of pods per plant
4. Number of seeds per pod
5. Shoot dry weight
6 hundred seeds weight
7. Seed yield
8. Harvest index
9. Percent protein
10. percent of starch

Harvest index

Mean comparison showed that the impact of bio-fertilizer was applied maximum of withdrawal of treatment, (45.77 percent) (Figure 10) In terms of effect of vermicomposting greatest amount of harvest index was observed in vermicomposting treatment seven tons per hectare. (44.44%) (Figure 11) The average data in terms of interaction N × phosphorus fertilizer showed the highest harvest index in treatment 100 kg N (60.22 percent), respectively. (Figure 12)

Tohidi Moghaddam and colleagues (2006) in an experiment to reduce the use of chemical fertilizers and replacing them with biological fertilizers reported that the highest harvest index of soybean seeds inoculated with bio fertilizers and consumption of 25 kg per hectare phosphate fertilizer urea fertilizer superphosphate and 15 kg respectively. Algyzavy and colleagues (2009) reported that application of 30 kg phosphorus ha with Phosphate Solubilizing Bacteria bean crop increased harvest index.

Ghanbari et al (2013) The Effect of tea waste mulching and hand weeding on some morphological characteristics and protein and starch landraces of beans (Phaseolus vulgaris L) Soil organic matter or compost stated that by increasing the activity of an enzyme (acid phosphatase, dehydrogenase and Pronease) and increased harvest index, and grain yield.

Shirani Rad et al (1999) also reported that phosphate solubilizing bacteria improve plant growth and development of systems to improve nutrient and water absorption, as a result, the rate of photosynthesis and dry matter production increased, and this increased harvest index. Ghalavand et al (2009) The Effect of organic fertilizers, bio and chemical fertilizers on yield and quality pea reported that the foundation had significant effect on the harvest index. Interaction between base fertilizer and bio-fertilizers and trilateral interactions with vermicomposting also harvest index was significant.

Percent protein

Data variance analysis, showed levels of nitrogen fertilizer, phosphorus fertilizer, bio-fertilizer, vermicomposting, the interaction of N × phosphorus fertilizer, nitrogen × bio-fertilizer, bio-fertilizer × phosphorus fertilizer, bio-fertilizer × vermicomposting, N × fertilizer and bio-fertilizer × phosphorus × bio-fertilizer × phosphorus fertilizer vermicomposting significant effect on grain protein content and interaction in the probability of one per cent phosphorus fertilizer × N × organic fertilizer × vermicomposting was significant on the level of five percent. (Table 2)

The results of the comparison of terms of interaction N × phosphorus fertilizer × × vermicomposting organic fertilizers showed that the highest amount of protein in the treatment of 100 kg N, 100 kg phosphorus fertilizer, bio-fertilizer and use 7 tonnes of vermicomposting ha, (31.43 percent) that with treatment 100 kg of nitrogen, 50 kg phosphorus fertilizer, bio-fertilizer and application of vermicomposting 7 tons per hectare was not significantly different and the lowest in control (9.77 percent). (Table 4)

Tohidi Moghaddam and colleagues (2006) in an experiment to reduce the use of chemical fertilizers and replacing them with organic fertilizers reported that the highest protein content of soybean seeds inoculated with bio fertilizers and consumption of 25 kg per hectare phosphate fertilizer superphosphate and 15 kg urea was obtained. Algyzavy and colleagues (2009) reported that application of 30 kg ha phosphorus fertilizer with phosphate solubilizing bacteria increases the protein content in the crop beans.

Banati (2007) reports grain protein genetic and environmental factors contributing to the growth and development such as temperature, soil nitrogen content, duration, day and time depend on grain handling.

Ghanbari et al (2013) The Effect of tea waste mulching and hand weeding on some morphological characteristics and protein and starch bean landraces (acidity aseolus vulgaris L.) Stated that with increase in organic matter or compost soil enzyme activities (acid phosphatase, dehydrogenase and Pronease) and also nitrate reductase enzyme is a key enzyme in the conversion rate, in particular nitrogen to nitrite in the cycle is the synthesis of amino acids and thus increase the protein content is increased.

Shirani Rad et al (1999) reported that phosphate solubilizing bacteria improve plant growth and development of systems to improve nutrient and water absorption, as a result, the rate of photosynthesis and production of photosynthesis increases and this causes an increase in total dry weight of the plant. Since the total amount of nitrogen plant positive correlation with total dry weight, the amount of total nitrogen plant and consequently increases the amount of plant protein.

Study results showed that the correlation coefficient is positive and significant correlation between grain protein percent with all the attributes and the highest correlation with grain yield. (** 0.953) (Table 3

The overall conclusion

According to the results of the present experiment the use of bio-fertilizers and nitrogen and phosphorus fertilizers vermicomposting with reduce consumption and increase the efficiency of nitrogen and phosphorus fertilizer is. All yield and yield components under the effect of nitrogen fertilizer, phosphorus fertilizer, bio-fertilizer and vermicomposting were, and overall consumption of 100 kg N, 100 kg phosphorus, organic fertilizer and the use of vermicomposting increased the number of pods per plant, seeds per pod, shoot dry weight, hundred seeds weight, grain yield and harvest index.

Almost all of the traits in combination with organic manure and vermicomposting in terms of quality and quantity recovered, if the effect of the interaction of nitrogen × P, N × N × vermicomposting on bio-fertilizer and seed yield and integration vermicomposting was no significant yield. Only four percentage protein interactions were affected. Finally, it may be concluded that the Gilan province in the area of bio-fertilizers and phosphate solubilizing and vermicomposting can be used in conjunction with fertilizers to increase the quality and quantity of grain used in bean plants.

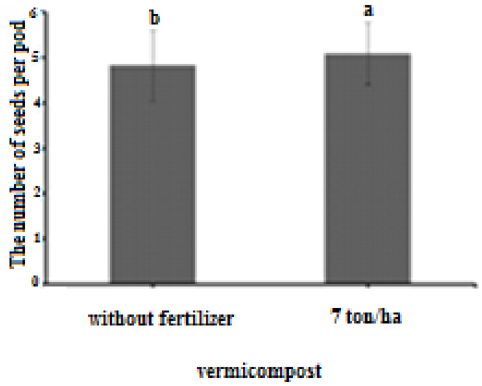

Figure 1: The number of seeds per pod in terms of vermicomposting

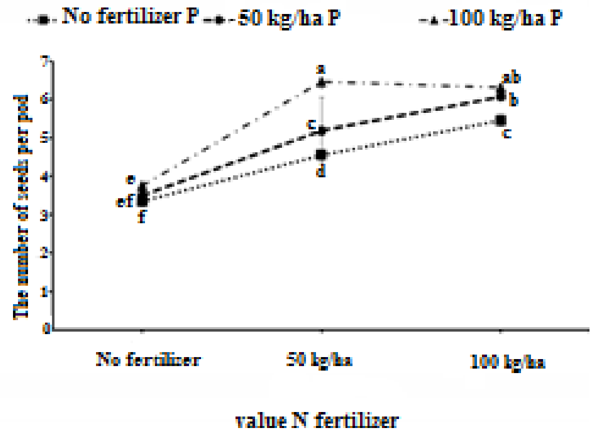

Figure 2: seeds per pod values in the interaction N × phosphorus fertilizer

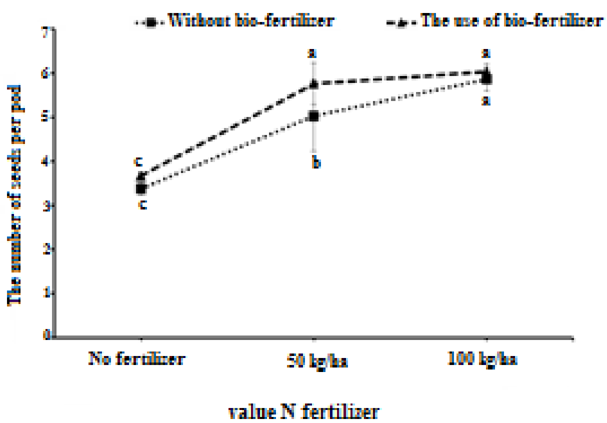

Figure 3: seeds per pod values in the interaction N × bio fertilizers

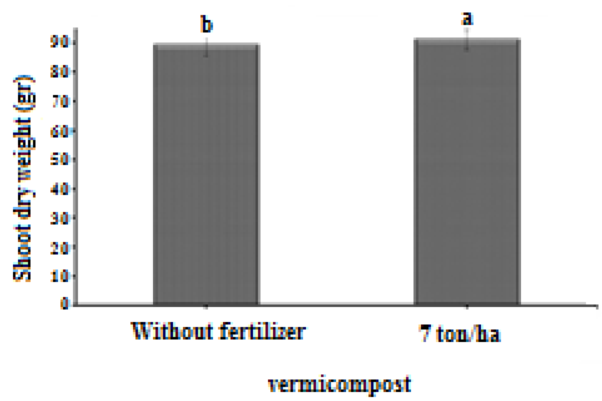

Figure 4: Shoot dry weight in terms of quantities of vermicomposting

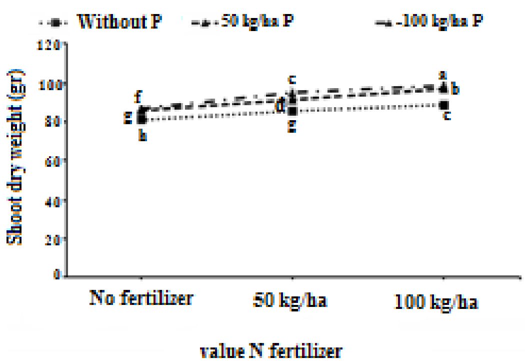

Figure 5: Shoot dry weight values in the interaction N × phosphorus fertilizer

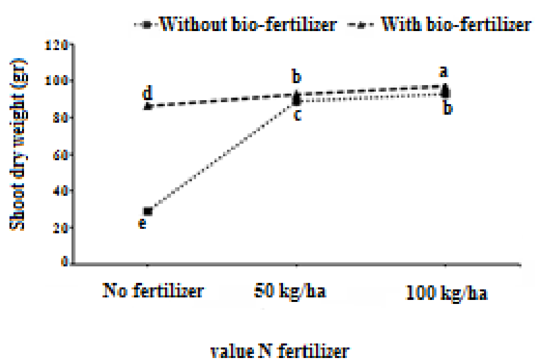

Figure 6: Shoot dry weight values in the interaction N × bio fertilizers

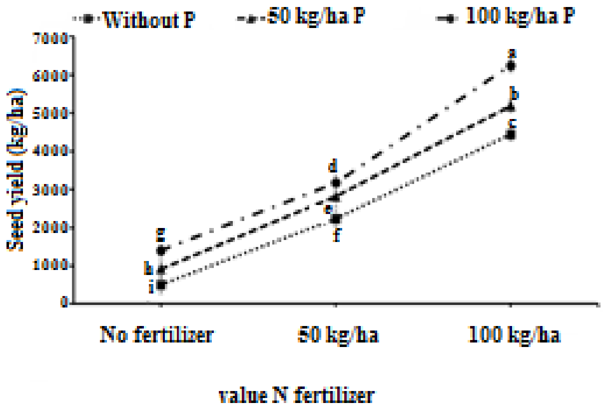

Figure 7: quantities of seed yield in the interaction N × phosphorus fertilizer

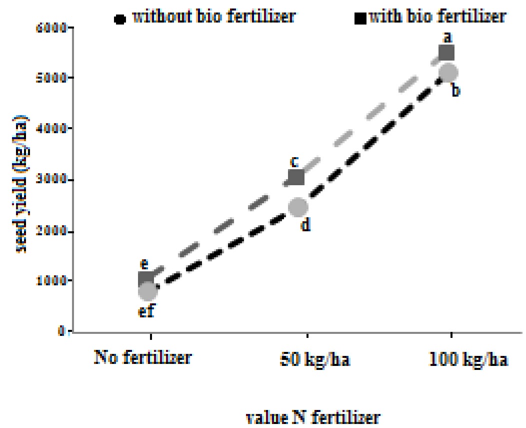

Figure 8: quantities of seed yield in the interaction N × bio fertilizers

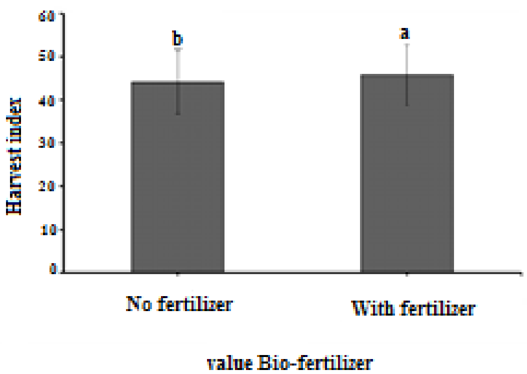

Figure 9: quantities of seed yield in the interaction N × vermicomposting

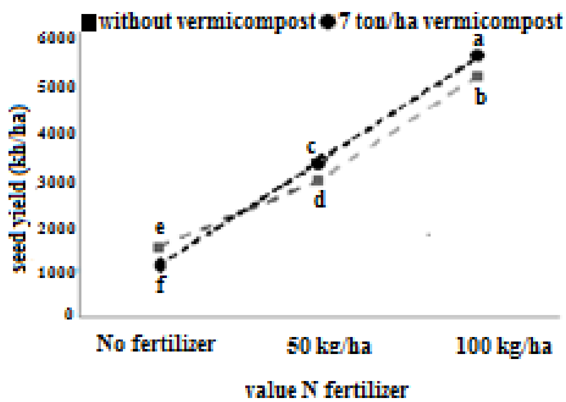

Figure 10: The harvest index in different amounts of bio fertilizer

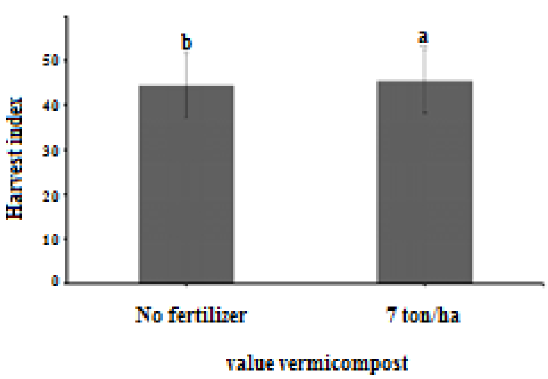

Figure 11: harvest index in different levels of vermicomposting

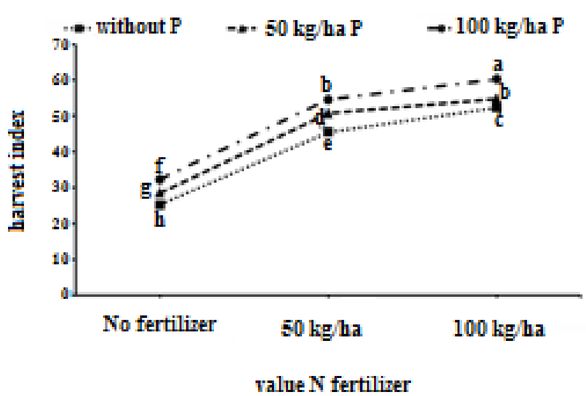

Figure 12: harvest index values in the interaction N × phosphorus fertilizer

Table 4: Average plant height and protein interaction N × phosphorus fertilizer × bio-fertilizer × vermicomposting

Evaluated feature				
Protein percent	Vermicompost	Bio fertilizer	Phosphorus fertilizer	Nitrogen fertilizer
9.77w	No fertilizer	No fertilizer	No fertilizer	No fertilizer
11.10tuv	7 tons per hectare			
11.87s	No fertilizer	With fertilizer		
14.06q	7 tons per hectare			
10.50vw	No fertilizer	No fertilizer	50 kilogram / hectare	
11.26stu	7 tons per hectare			
11.76st	No fertilizer	With fertilizer		
14.10q	7 tons per hectare			
11.01uv	No fertilizer	No fertilizer	100 kilogram / hectare	
13.07r	7 tons per hectare			
14.13q	No fertilizer	With fertilizer		
15.52p	7 tons per hectare			
16.97mn	No fertilizer	No fertilizer	No fertilizer	50 kilogram / hectare
17.65lm	7 tons per hectare			
15.97op	No fertilizer	With fertilizer		
19.05k	7 tons per hectare			
16.04op	No fertilizer	No fertilizer	50 kilogram / hectare	
17.88l	7 tons per hectare			
18.23l	No fertilizer	With fertilizer		
20.02j	7 tons per hectare			
16.55no	No fertilizer	No fertilizer	100 kilogram / hectare	
18.24l	7 tons per hectare			
20.25j	No fertilizer	With fertilizer		
22.21i	7 tons per hectare			
25.33gh	No fertilizer	No fertilizer	No fertilizer	100 kilogram / hectare
27.31e	7 tons per hectare			
26.27f	No fertilizer	With fertilizer		
29.08b	7 tons per hectare			
25.96fg	No fertilizer	No fertilizer	50 kilogram / hectare	
28.12d	7 tons per hectare			
28.29cd	No fertilizer	With fertilizer		
31.09a	7 tons per hectare			
25.13h	No fertilizer	No fertilizer	100 kilogram / hectare	
27.88de	7 tons per hectare			
29.02bc	No fertilizer	With fertilizer		
31.42a	7 tons per hectare			

Table 5: Average number of pods per plant and hundred seeds weight in the study of the interaction phosphorus × N × fertilizer bio-fertilizer

Evaluated features				
Seed weight	Number of seed in pod	Treatment		
		Bio fertilizer	Phosphorus fertilizer	Nitrogen fertilizer
104.57n	5.33o	No fertilizer	No fertilizer	No fertilizer
111.41m	5.71m	With fertilizer		
119.37k	5.53n	No fertilizer	50 kilogram / hectare	
125.62h	5.71m	With fertilizer		
121.95j	5.85l	No fertilizer	100 kilogram / hectare	
128.99fg	6.06k	With fertilizer		
116.91l	6.40j	No fertilizer	No fertilizer	50 kilogram / hectare
124.32i	6.78i	With fertilizer		
125.79h	7.36h	No fertilizer	50 kilogram / hectare	
128.84g	8.01f	With fertilizer		
126.26h	8.68d	No fertilizer	100 kilogram / hectare	
131.91e	9.40b	With fertilizer		
126.29h	7.70g	No fertilizer	No fertilizer	100 kilogram / hectare
130.03f	8.35e	With fertilizer		
135.05d	8.65d	No fertilizer	50 kilogram / hectare	
139.06c	9.00c	With fertilizer		
142.66b	9.38b	No fertilizer	100 kilogram / hectare	
146.48a	9.55a	With fertilizer		

Table 6: Average traits interact × N × phosphorus fertilizer vermicomposting

Evaluated features				
Seed weight	Number of seed in pod	Treatment		
		Vermicomposting	Phosphor fertilizer	Nitrogen fertilizer
107.13o	5.43m	No fertilizer	Without fertilizer	No fertilizer
108.85n	5.61l	7 tons per hectare		
121.12l	5.50m	No fertilizer	50 kilogram in hectare	
123.87j	5.75k	7 tons per hectare		
123.89j	5.85k	No fertilizer	100 kilogram in hectare	
127.06gh	6.06j	7 tons per hectare		
118.83m	6.48i	No fertilizer	Without fertilizer	50 kilogram / hectare
122.40k	6.70h	7 tons per hectare		
125.71i	7.55g	No fertilizer	50 kilogram in hectare	
128.92ef	7.83f	7 tons per hectare		
128.16fg	8.86c	No fertilizer	100 kilogram in hectare	
130.01e	9.21b	7 tons per hectare		
126.95h	7.88f	No fertilizer	Without fertilizer	100 kilogram / hectare
129.37e	8.16e	7 tons per hectare		
135.57d	8.75d	No fertilizer	50 kilogram in hectare	
138.54c	8.90c	7 tons per hectare		
142.68b	8.46a	No fertilizer	100 kilogram in hectare	
146.46a	8.46a	7 tons per hectare		

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