COMBINED EFFECT OF CHICKPEA CULTIVATION AND TYPE OF FERTILIZER ON GROWTH, YIELD AND MINERAL ELEMENT CONCENTRATION OF CORN (*ZEA MAYS* L.)

JAHANBAN, L.[1,2] – PANAHPOUR, E.[2*] – GHOLAMI, A.[2] – DAVARI, M. R.[3] – LOTFIFAR, O.[3]

[1]*Department of Soil Science, Khouzestan Science and Research Branch, Islamic Azad University, Khouzestan, Iran; e-mail: leilajahanban@yahoo.com*

[2]*Department of Soil Science, College of Agriculture, Ahvaz Branch, Islamic Azad University, Ahvaz, Iran*

[3]*Agriculture Department, Payam Noor University, Tehran, Iran*

**Corresponding author*
e-mail: e.panahpour@gmail.com

(Received 22nd Jan 2018; accepted 25th Apr 2018)

Abstract. The aim of this study was to assess effects of prior cultivation in combination with bio-fertilizers and the use of combined fertilizers and on corn (*Zea mays* L.) yield and soil efficacy. A strip-plot randomized complete block design with three replications was used in 2015 at the research farm of Payam-e Nour University in Arak, Iran. Treatments included the pre-cultivation with chickpeas and lying fallow. The fertilizer treatments were no organic fertilizer (control); manure containing 60 kg N per ha [FYM]; vermicompost containing 60 kg N per ha [VC]; FYM + 3000 kg chickpea waste/ha [M]; VM+M; FYM+M+ bio-fertilizer (Celolitec Kalchero) and phosphate-solubilizing bacteria [B] + azetobacter; vermicompost containing 60 kg N/ha + 3000 kg chickpea waste/ha + Celolitec Kalchero and; VC+M+B). The results showed that the effect of pre-cultivation with chickpeas on plant height, fresh forage yield, leaf phosphorus, leaf protein, organic carbon, available soil nitrogen and available soil phosphorus were significant. The effect of fertilizer type on all traits (except grain width) was significant. The highest phosphorus (5.53 mg/g), grain protein (10.57%), length of corncob (17.17 cm), grain width (2.18 mm), grain length (9.48 mm), fresh forage yield (22436.7 kg/h) and raw ash (6.60 mg/g) were obtained with the VC+M+B treatments. Leaf phosphorus and fresh forage yield after pre-cultivation with chickpeas were higher than for the fallow pre-treatment.
Keywords: *grain yield, biofertilizer, chickpea, vermicompost, fallow, organic matter*

Introduction

Corn is the world's third most important dual-purpose crop (grain and forage). It plays an important role in human and animal nutrition. Corn forage used for livestock feed provides a high amount of energy, is not harmful and is free of substances such as prussic acid and oxalic acid which are found in plants such as sorghum. It also can be consumed by livestock at all stages of growth (Dahmardeh et al., 2009; Hollander et al., 2007).

Recent attention has focused on the quality and health of the soil in order to produce sustainable crops. Many countries have encouraged the use of natural inputs out of growing concern for the safety of food products (Hollander et al., 2007). The frequent use of chemical fertilizers and lack of soil conservation in ways that are destructive to soil organisms eventually leads to loss of vitamins and other beneficial compounds in plants which are essential to their production (Hiltbrunner et al., 2007).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1603_31593169

Currently, the fertilization system focuses on the supply of a few macronutrients, although plants need at least 13 types of mineral nutrients which come from the soil. This is another reason for the imbalance in plants that are fed mineral fertilizers (Atiyeh et al., 2000).

Manure and vermicompost are widely used organic fertilizers. In addition to the usual benefits of compost, vermicompost is a source of organic substances, improves the water-holding capacity of the soil, increases absorption of nutrients and has a hormone-like effect on the plant (Bachman and Metzger, 2008; Campitelli and Ceppi, 2008). Vermicompost is finer and better in texture than compost and has nutrient forms that are easily absorbed by plants (Roy et al., 2010). Studies have shown that the presence of plant growth regulators in vermicompost improves plant growth (Atiyeh et al., 2000). A study on chickpeas showed that the application of three tons of vermicompost per hectare significantly increased the biomass over that of the control (Kapoor et al., 2002). Zaller (2007) showed that vermicompost significantly increased the biomass of tomato varieties.

Biological fertilizer is organic fertilizer derived from animals, plants and other types of waste that includes microorganisms that act in relation to the fixation of nitrogen, phosphorus and other nutrients in the soil (Kumar et al., 2014). One way to achieve sustainable agriculture is the use of microorganisms, which play an important role in the nutrition of plants (Abdel-Aziez et al., 2016).

Currently, phosphate-solubilizing microorganisms (PSMs) are used as biological fertilizer to increase yield and maintain soil health (Khan et al., 2010). Studies have shown that PSMs dissolve phosphorus that is fixed in the soil and improves plant yield (Gull et al., 2004). Research also showed that PSMs increase the germination, absorption of nutrients, plant height and number of branches, nodules, biomass and chickpea yield over that of the control (Rudresh et al., 2005).

One element that limits crop yield is nitrogen. Product waste, especially from legumes, which have a symbiotic relationship with the bacteria of the rhizobium family can improve soil nitrogen. The aim of this study was to investigate the effect of pre-cultivation with chickpeas and the application of phosphorus and nitrogen dissolvent and chickpea waste to increase the efficiency of vermicompost and manure for corn and soil efficacy.

Materials and methods

This experiment was done in 2015 on the research farm of Payam-e Nour University in Arak, Iran (34° N and 50° E at 1757 m in elevation). This experiment was a strip-plot randomized complete block design with three replications. The region has a cold steppe climate, an average rainfall of 250-350 mm, a maximum temperature of 40 °C and a minimum temperature of -7 °C (for more detail, see *Table 1*).

The pre-cultivation treatments were 1- chickpeas and 2- lying fallow. The organic fertilizers were as follows: 1- control (without fertilizer); 2- manure containing 60 kg N/ha (FYM); 3- vermicompost containing 60 kg N/ha (VC); 4- manure containing 60 kg N/ha + 3000 kg chickpea waste/ha (FYM+M); 5- vermicompost containing 60 kg N/ha + 3000 kg chickpea waste/ha (M+VM); 6- manure containing 60 kg N/ha + 3000 kg chickpea waste/ha + bio-fertilizer (Celolitec Kalchero) + phosphate-solubilizing bacteria + azotobacter (B+M+FYM); 7- vermicompost

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1603_31593169

containing 60 kg N/ha + 3000 kg chickpea waste/ha + Celolitec Kalchero + phosphate-solubilizing bacteria (Barvar 2) + azotobacter (VC+M+B).

Table 1. *Soil physical and chemical properties of field*

EC (dS/m)	pH	Saturation Percentage	Available P (ppm)	Available K (ppm)	Total N (%)	Total C (%)	Soil texture
1.73	7.9	27.05	12.1	302	0.052	0.52	Sandy loam

Each plot consisted of four rows 6 m in length. The distance between rows was 35 cm and the plant spacing was 10 cm. The density of the plants was 28.5 plants/m^2. Before applying the treatments, soil sampling was done from different parts of the farm and the results are shown in *Table 2*.

Table 2. *Monthly meteorological data of the experimental site (Arak-2014)*

Climate variable	J	F	M	A	M	J	J	A	S	O	N	D
Precipitation (mm)	5.2	46.9	50.2	33.5	11.6	2.1	6	0.4	3.7	51.6	49.1	34.5
Mean temperature (°C)	3.6	5.8	8.1	14.9	20.8	27.1	28.5	26.9	21.4	16.5	6.6	-0.5
Maximum temperature (°C)	14.8	18.4	21.6	32.4	40.2	39.8	37.8	33.6	30.6	20.6	20.2	17
Minimum temperature (°C)	-8.8	-6.6	-6.6	1.6	6.2	13.6	15	15.4	8.4	5	-4.2	-8.8

In order to prepare the field for planting, fertilizer was added to the soil in the amount required for each treatment. It was mixed with the soil using a disc to a depth of 30 cm. The corn variety used in this experiment was the single-cross 704. Barvar 2 is a phosphate-solubilizing fertilizer containing *Pantoea agglomerans* strain (P5) and *Pseudomonas putida* strain (P13) that was used in some treatments. The date of planting was 6 June, which is the usual time for the region. During the growth season, irrigation was carried out as needed and weed control was done manually. The protein content of grain was determined by Kjeldahl method (N × 6.25, wet basis) (Wang et al., 2016).

Phosphorus contents of corn leaf and soil were determined using spectrophotometer (UVD 2960). Dried material was burned in a muffle furnace at 550°C and used to determine the raw ash content (Theuretzbacher et al., 2014).

At the early dent, after removing the half-a-meter margins from both sides of the planting lines and two lateral lines, harvesting was carried out near the soil surface. In each plot, six plants were selected. After measuring the growth characteristics of plant height, length, width and grain thickness, diameter and ear length and fresh yield, the plants were transferred to the laboratory and the amount of plant nutrients in them was determined. The protein content was determined as by Kjeldahl at N = 6.25. Phosphorus was estimated using a spectrophotometer. SAS (ver. 11) software was used to analyze the variance of data. LSD 0.05 values were used for comparison of means.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1603_31593169

Results

The results showed that the effects of prior cultivation on plant height, fresh forage yield, leaf phosphorus, leaf protein, organic carbon, available soil nitrogen and available soil phosphorus were significant at the 1% level. The effect of fertilizer type on grain length, ear length, plant height, fresh forage yield, phosphorus, leaf and seed protein content, organic carbon, available soil nitrogen and available soil phosphorus were significant at the 1% level and on grain thickness, corncob diameter, crude fiber and crude ash content at the 5% level. The interactions of prior cultivation and fertilizer type with plant height, organic carbon, available soil nitrogen and available soil phosphorus were significant at the 1% level (*Tables 3* and *4*).

Table 3. *Analysis-of-variance of corn traits under different fertilizer and prior cultivation treatments*

		MS							
S.O.V.	**d.f.**	**Grain length**	**Grain width**	**Grain thickness**	**Corncob length**	**Corncob diameter**	**Plant height**	**Fresh forage yield**	**Leaf phosphorus**
Replication	2	0.0512	0.1608	0.1545**	0.0535	0.3848	2.08	60016.7*	0.0196
Prior cultivation (a)	1	0.4588	0.0952	0.0415	0.0841	0.8204	443.92**	722859/5**	1.6521**
Error (a)	2	0.0588	0.2804	0.0042	0.0067	1.3188	0.86	2759-5	0.0020
Fertilizer (b)	6	0.8739**	0.0894	0.0420*	0.7442**	1.4968*	2114.19**	6116643/6**	10.3000**
Error (b)	12	0.0236	0.01874	0.0110	0.0110	0.3763	4.20	5630.6	0.0097
a*b	6	0.0394	0.2043	0.0001	0.0020	0.0804	18.76**	10437/3	0.0833
Error	12	0.0877	0.2139	0.0183	0.0106	0.4048	2.52	7945.6	0.0116
C.V.	**-**	0.98	7.46	0.98	0.61	2.98	1.35	0.42	2.99

*Significant at $P \leq 0.05$
**Significant at $P \leq 0.01$

Table 4. *Analysis-of-variance of corn traits under different fertilizer and prior cultivation treatments*

		MS						
S.O.V.	**d.f.**	**Leaf potassium**	**Grain protein**	**Raw fiber**	**Raw ash**	**Soil organic carbon**	**Available soil nitrogen**	**Available soil phosphorus**
Replication	2	1.60	0.4570	0.0202	0.0416	143211/3	911.9	24123.6
Prior cultivation (a)	1	508.22**	5.6467	0.0229	0.0293	1217320.9**	2981.2**	32121.2**
Error (a)	2	0.29	0.3553	0.0023	0.0113	2312345/0	499.5	7111.2
Fertilizer (b)	6	1707.60**	21.8756**	0.0072ns	0.1906*	11598411.9**	1212.1**	32219.9**
Error (b)	12	0.68	0.1868	0.0061	0.0282	1168564/6	321.0	5049.0
a*b	6	4069**	0.0461	0.0006	0.0006	1214320.9**	1001.2**	12321.1**
Error	12	0.45	0.2312	0.0202	0.0119	431153/4	291.3	4025.6
C.V.		0.98	5.75	0.38	1.72	11.9	8.3	11.4

*Significant at $P \leq 0.05$
**Significant at $P \leq 0.01$

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1603_31593169

Grain characteristics

The largest values for grain length and grain thickness were obtained from the treatments containing three fertilizers. Then next largest values were for the two-fertilizer treatment followed by a single fertilizer. The lowest amount was observed in the control treatment (without fertilizer). The length and thickness of the grains, respectively, were 14% and 12% for VC+M+B, 12% and 11% for FYM+M+B, 11% and 11% for VC+M, 11% and 9% for FYM+M, 8% and 7% for VC, 10% and 6% higher for FYM greater than for the control without fertilizer. In general, grain yield and grain thickness were higher in the compost treatments than in the manure treatments, but the difference between these was not significant.

Ear characteristics

The greatest lengths and diameters of corncobs were found in the three-fertilizer treatments and the lowest in the control treatment (without fertilizer). The length of the corncob in both the three-fertilizer treatments (VC+M+B and FYM+M+B) increased by 6% and in the FYM+M, VC+M, FYM and VC treatments by 5% when compared to the control (*Table 4*). The treatments containing compost resulted in greater corncob lengths than those with manure at all levels of fertilization, but the difference was not significant. All fertilizer treatments increased the corncob diameter over that of the control (*Table 5*).

Table 5. *Mean comparisons of corn traits under different fertilizer*

Treatments	Mean			
	Grain length (mm)	Grain width (mm)	Corncob length (cm)	Corncob diameter (mm)
CO	8.31^{e}	1.92c	16.12^{d}	20.24^{b}
FYM	9.12^{cd}	2.04^{bc}	16.91^{c}	21.32^{a}
VC	8.98^{d}	2.06^{ab}	16.92^{c}	21.34^{a}
FYM+M	9.20^{bc}	2.10^{ab}	16.98^{bc}	21.44^{a}
VC+M	9.26^{bc}	2.12^{ab}	17.02^{bc}	21.52^{a}
FYM+M+B	9.33^{ab}	2.15^{ab}	17.10^{ab}	21.70^{a}
VC+M+B	9.48^{a}	2.18^{a}	17.17^{a}	21.67^{a}

CO: control; FYM: manure containing 60 kg N/ha; VC: vermicompost containing 60 kg N/ha; M: 3000 kg chickpea waste/ha; N: bio-fertilizer (Celolitec Kalchero) + phosphate-solubilizing bacteria + azotobacter

Plant height

The plant height at all levels of fertilization except for VC+M, was higher with chickpea pre-cultivation than with no pre-treatment (6% increase in plant height over the control). The greatest plant height with and without cultivation was observed for VC+M+B and the lowest was for the control (*Table 8*).

Yield of fresh forage

The highest fresh forage yield was obtained for VC+M+B and FYM+M+B (15% and 14% increase over the control, respectively). The VC+M and FYM+M combinations

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1603_31593169

increased 13% and 11%, respectively, over the control and the VC and FYM treatments increased 9% and 4%, respectively, over the control (*Table 6*). The use of vermicompost in all fertilizer treatments increased the yield over that of the manure treatment. The prior cultivation treatment significantly increased the yield of forage by 361 kg over the fallow treatment (*Table 6*).

Table 6. *Mean comparisons of corn traits under different fertilizer*

Treatments	Mean			
	Fresh forage yield (kg/ha)	**Leaf phosphorus (mg/g)**	**Grain protein (%)**	**Raw ash (mg/g)**
CO	19473.3[f]	1.96[g]	5.17[e]	6.08[e]
FYM	20220.0[e]	2.52[f]	7.01[d]	6.23[de]
VC	21220.7[e]	2.70[e]	7.54[d]	6.30[cde]
FYM+M	21586.7[d]	3.64[d]	8.72[c]	6.35[bcd]
VC+M	21991.7[c]	3.89[c]	9.32[b]	6.45[abc]
FYM+M+B	22163.3[b]	4.95[b]	10.16[a]	6.52[ab]
VC+M+B	22436.7[a]	5.53[a]	10.57[a]	6.60[a]

CO: control; FYM: manure containing 60 kg N/ha; VC: vermicompost containing 60 kg N/ha; M: 3000 kg chickpea waste/ha; N: bio-fertilizer (Celolitec Kalchero) + phosphate-solubilizing bacteria + azotobacter
Within columns, means followed by the same letter do not differ significantly ($p \leq 0.05$)

Leaf phosphorus

This trait was strongly influenced by the type of fertilizer used. The amount of phosphorus of in the leaves of the VC+M+B and FYM+M+B treatments increased by 182% and 152%, respectively. For the VC+M and FYM+M treatments, respectively, it increased by 98% and 86% and in the VC and FYM treatments by 38% and 28%, respectively (*Table 6*). Fertilizer treatments containing vermicompost showed significantly higher levels of phosphorus over treatments containing manure (*Table 6*). The difference between the fallow and pre-cultivation with chickpeas was significant in terms of leaf phosphorus content. The chickpea treatment showed an 11% increase in leaf phosphorus over the fallow treatment (*Table 7*).

Table 7. *Mean comparisons of corn traits under different prior cultivation treatments*

Treatments	Mean	
	Fresh forage yield (kg/ha)	**Leaf phosphorus(mg/g)**
Fallow	21291.81[b]	3.39[b]
Pre-pea cultivation	21553.18[a]	3.80[a]

Within columns, means followed by the same letter do not differ significantly ($p \leq 0.05$)

Grain protein

The highest protein content in the seeds was observed in the three-fertilizer treatments. The lowest protein content was observed in the non-fertilized (control) treatment. Grain protein content in the VC+M+B and FYM+M+B increased by 104%

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1603_31593169

and 97%, respectively. In the VC+M and FYM+M treatments, it increased 80% and 67%, respectively, and in the VC and FYM treatments, it increased 46% and 36%, respectively, over the control (*Table 6*). There was no significant difference in this trait between the vermicompost and manure treatments.

Raw ash

The highest raw ash content was observed in the three-fertilizer treatment of VC+M+B (9% increase compared to control); however, the difference was not significant from the FYM+M+B (7% increase compared to control) and VC+M (6% increase compared to control). The lowest ash content was observed in the control treatment (*Table 6*).

Soil properties

The traits of soil organic carbon, available soil nitrogen and available soil phosphorus were strongly influenced by the simple effects of fertilizer type and pre-cultivation and the interaction of these treatments was also significant ($p < 0.01$; *Table 4*). Pre-cultivation with chickpeas at almost all levels of fertilizer increased the levels of organic carbon, available soil nitrogen and phosphorus because of the effects of chickpea cultivation that remained in the soil. Soil organic carbon is one of the most important factors for soil and production capacity and is a major reason for the higher values of most traits in the pre-cultivation with chickpea treatment over the fallow treatment. Fertilizers contained higher amounts of organic carbon compared to the control. The highest available soil nitrogen levels were 0.887% and 0.844% in the VC+M+B and FYM+M+B treatments, respectively, in the pre-cultivation with chickpea treatment (*Table 8*).

Table 8. *Interaction effect of fertilizer and prior cultivation on corn height and soil properties*

Pre-cultivation	Fertilizer treatment	Plant height (cm)	Organic carbon (%)	Available soil N (%)	Available soil P (ppm)
Fallow	CO	85.6 ^{j}	0.503 ^{e}	0.524 ^{h}	12.4 ^{g}
	FYM	98.2 ^{h}	0.531 ^{d}	0.642 ^{g}	13.8 ^{f}
	VC	104.5 ^{g}	0.532 ^{d}	0.670 ^{g}	13.9 ^{f}
	FYM+M	112.6 f	0.548 ^{c}	0.708 ^{fg}	14.7 ^{cd}
	VC+M	125.3 ^{d}	0.546 ^{c}	0.738 ^{ef}	14.8 ^{cde}
	FYM+M+B	132.6 ^{c}	0.550 ^{c}	0.722 ^{ef}	15.1 ^{cd}
	VC+M+B	138.4 ^{b}	0.554 ^{c}	0.741 ^{def}	15.3 ^{bc}
Chickpea	CO	92.8 ^{i}	0.492 ^{f}	0.538 ^{h}	12.4 ^{g}
	FYM	106.3 ^{g}	0.553 ^{c}	0.724 ^{ef}	14.2 ^{ef}
	VC	113.9 ^{f}	0.572 ^{b}	0.759 ^{de}	14.4 ^{def}
	FYM+M	119.8 ^{e}	0.589 ^{a}	0.796 ^{cd}	15.1 ^{cd}
	VC+M	124.0 ^{d}	0.570 ^{b}	0.803 ^{bc}	15.9 ^{ab}
	FYM+M+B	140.6 ^{b}	0.597 ^{a}	0.844 ^{ab}	16.3 ^{a}
	VC+M+B	145.3 ^{a}	0.588 ^{a}	0.887 ^{a}	16.5 ^{a}

CO: control; FYM: manure containing 60 kg N/ha; VC: vermicompost containing 60 kg N/ha; M: 3000 kg chickpea waste/ha; N: bio-fertilizer (Celolitec Kalchero) + phosphate-solubilizing bacteria + azotobacter
Within columns, means followed by the same letter do not differ significantly ($p \leq 0.05$)

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1603_31593169

The highest available soil phosphorous was found in the three-fertilizer combination under pre-cultivation (16.5 and 16.3 ppm. respectively), dual fertilizer (15.9 ppm) and VC+M+B under fallow conditions (15.3 ppm). These results show how the strong synergistic effects of various fertilizers in the soil to improve its physical and nutritional status. Other researchers have reported vermicompost as a soil organic modifier for increased nitrogen and phosphorus absorption (Sekar and Karmegan, 2010).

Discussion

Based on the results of this experiment, the combination of fertilizers that included organic fertilizer, corn residue and biofertilizer achieved the high yield. It appears that the increase in absorption of nutrition by the plant in this type of treatment and subsequent improvement in growth conditions led to the increased yields.

Manure and vermicompost alone managed to improve the nutritional status of the plant and, subsequently, increased the relative yield compared to the control, but this increase was lower than for the combined fertilizer treatments. Darzi and Haj-Sihedadi (2012) reported that the use of high levels of vermicompost in dill cultivation significantly increased the yield and plant height. Other researchers reported an increase in the physical, chemical and biological properties of soil and improved plant nutritional conditions that were attributed to the increase in the duration of vegetative and reproductive growth, the better use of growth resources and an increase in yield components and grain yield (Arankon et al., 2004). Roesti et al. (2006 improvement of the soil fertility, prevention of the leaching of nitrogen, an increase of biological activity and improvement of the soil structure as resulting from the use of vermicompost. Vermicompost application has been found to stimulate soil microorganisms, maintained the supply of nutrients to the plant and increase yield (Roy and Singh, 2006). The use of vermicompost, in addition to supplying nutrients from worm residue, improves the soil biological conditions and increases the microorganism activity in the soil (Anwar et al., 2005). An increase in phosphorus uptake in the soil was found to increase soil nitrogen efficiency and ultimately result in better plant growth (Zubigala et al., 2002).

Simultaneous use of organic fertilizers, plant residue and biofertilizer increased the absorption of elements from the soil, proper growth of the plant and produced the highest biological yield and seed yield in corn. In many other studies, PSMs have also increased the phosphorus concentration in the soil and plant and ultimately improved yield (Gull et al., 2004). Research has also shown that the use of these microorganisms increased and improved the germination ability, absorption of elements, plant height, number of branches, biomass and yield of chickpeas compared to the control treatment (Rodrish et al., 2005).

These biofertilizers increase nutrient availability and produce growth hormones by increasing nitrogen efficiency. Gull et al. (2004) observed that phosphate-solubilizing bacteria increased the number of nodules in chickpeas by 50% and increased N fixation and concentration in the plant. The application of phosphorus solubilizing bacteria increased the phosphorus concentration, which increased nitrogen efficiency, which increased development of the plant shoot, root and leaf area and, ultimately, the yield (Soltani et al., 2010). Mokhtari and Besharati (2013) also showed that the use of phosphorus-soluble bacteria significantly increased the concentration of nitrogen, phosphorus, potassium, iron, and zinc compared to the control, which significantly increased the yield over that for the absence of bacteria.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1603_31593169

In the current study, pre-cultivation with chickpeas had positive effects on phosphorus soil availability and absorption, which increased the corn forage yield. Other studies have also found a positive effect of the adding of plant residue, especially legumes either by reversing the residue of the previous crop or adding residue to the field on soil characteristics, nutrient reserves in the soil and plant tissues and yield (Wilhelm et al., 2004). Fischer et al. (2002) showed that the return of plant residue is effective in providing more nitrogen and increasing the yield of corn and wheat, especially in the long-term, along with a more gradual decrease in soil fertility and degradation of yield. This makes the procedure economically advantageous.

Conclusion

As a conclusion the effect of pre-cultivation with chickpeas on more plant traits were higher than fallow. The highest phosphorus, grain protein, length of corncob, grain width, grain length, fresh forage yield and raw ash were obtained with the VC+M+B treatments. In more traits there were a synergistic effects of pre-cultivation with fertilizers compared with fallow plots.

REFERENCES

[1] Abdel-Aziez, S. M., Eweda, E. W., Girgis, M. G. Z., Abdel Ghany, B. F. (2016): Improving the productivity and quality of black cumin (Nigella sativa) by using Azotobacter as N2 biofertilizer. – Annals of Agricultural Sciences 59: 95-108. https://doi.org/10.1016/j.aoas.2014.06.014.

[2] Anwar, M., Patra, D. D., Chand, S., Alpesh, K., Naqvi, A. A., Khanuja, S. P. S. (2005): Effect of organic manures and inorganic fertilizer on growth, herb and oil yield, nutrient accumulation, and oil quality of French basil. – Communications Soil Science Plant Analysis 36: 1737-1746. https://doi.org/10.1081/CSS-200062434.

[3] Arancon, N. Q., Edwards, C. A., Bierman, P., Welch, C., Metzger. J. D. (2004): Influences of vermicomposts on field strawberries: 1. Effects on growth and yields. – Bioresource Technology 93: 145-153. https://doi:10.1016/j.biortech.2003.10.014.

[4] Atiyeh, R. M., Subler, S., Edwards, C. A., Bachman, G., Metzger, J. D., Shuster, W. (2000): Effects of vermicomposts and compost on plant growth in horticultural container media and soil. – Pedobiologia 44: 579-590.

[5] Bachman, G. R., Metzger, J. D. (2008): Growth of bedding plants in commercial potting substrate amended with vermicompost. – Bioresource Technology 99: 3155-3161. https://doi:10.1016/j.biortech.2007.05.069.

[6] Campitelli, P., Ceppi, S. (2008): Effects of composting technologies on the chemical and physicochemical properties of humic acids. – Geoderma. 14: 325-333.

[7] Dahmardeh, M., Ghanbari, A., Syasar, B., Ramroudi, M. (2009): Effect of intercropping maize with cowpea on green forage yield and quality evaluation. – Asian Journal of Plant Science 8: 235-239.

[8] Darzi, M. T., Haj Seyed Hadi, M. R. (2012): Effects of the application of organic manure and biofertilizer on the fruit yield and yield components in Dill (*Anethum graveolens*). – Journal of Medicinal Plant Research 6: 3266-3271.

[9] Den Hollander, N. G., Bastiaans, L., Kropff, M. J. (2007): Clover as a cover crop for weed suppression in an intercropping design. II. Competitive ability of several clover species. – European Journal of Agronomy 26: 104-112. http://dx.doi.org/10.1016/j.eja.2006.08.005.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/1603_31593169

[10] Fischer, R. A., Santiveri, F., Vidal, I. R. (2002): Crop rotation, tillage and crop residue management for wheat and maize in the sub-humid tropical highlands. – Field Crops Research 79: 107-122. https://doi.org/10.1016/S0378-4290(02)00157-0.

[11] Gull, F. Y., Hafeez, I., Saleem, M., Malik, K. A. (2004): Phosphorus uptake and growth promotion of chickpea by co-inoculation of mineral phosphate solubilizing bacteria and a mixed rhizobial culture. – Australian Journal of Experimental Agriculture 44: 623-628. https://doi.org/10.1071/EA02218.

[12] Hiltbrunner, J., Streit, B., Liedgens, M. (2007): Are seeding densities an opportunity to increase grain yield of winter wheat in a living mulch of white clover? – Field Crop Research 102: 163-171.

[13] Kapoor, R., Giri, B., Mukerji, K. G. (2002): Glomus macrocarpum: a potential bioinoculant to improve essential oil quality and concentration in Dill (*Anethum graveolens* L.) and carum (*Trachyspermum ammi* Sprague). – World Journal of Microbiology and Biotechnology 18: 459-463.

[14] Khan, M. A., Shereen, A., Mumtaz, M. Y., Aqil Siddiqui, M. U., Kaleri, G. M. (2010): Evaluation of high yielding canola type Brassica genotypers/mutants for drought tolerance using physiological indices as screening tool. – Pakistan Journal of Botany 42: 3807-3816.

[15] Kumar, S., Bauddh, K., Barman, S. C., Sing, R. P. (2014): Amendments of microbial biofertilizers and organic substances reduces requirement of urea and DAP with enhanced nutrient availability and productivity of wheat (*Triticum aestivum* L). – Ecological Engineering 71: 432-437. https://doi.org/10.1016/j.ecoleng.2014.07.007.

[16] Mokhtari, M., Besharati, H. (2013): The effect of phosphate solubilizing bactria on yield and some chemical composition of corn plants. – Iranian Journal of Soil Research (Formely Soil and Water Science) 27: 619-628 (in Persian with English abstract).

[17] Roesty, D., Gaur, R., Johri, B. N. (2006): Plant growth stage, fertilizer management and bio-inoculation of arbuscular mycorrhizal fungi and plant growth promoting rhizobacteria affect the rhizobacterial. Community structure in rain-fed wheat fields. – Journal of Plant Science 38: 1111-1120. http://dx.doi.org/10.1016/j.soilbio.2005.09.010.

[18] Roy, D. K., Singh, B. P. (2006): Effect of level and time of nitrogen application with and without vermicompost on yield, yield attributes and quality of malt barley (*Hordeum vulgare*). – Indian Journal of Agronomy 51: 40-42.

[19] Roy, S., Arunachalam, K., Kumar Dutta, B., Arunachalam, A. (2010): Effect of organic amendments of soil on growth and productivity of three common crops viz. *Zea mays*, *Phaseolus vulgaris* and *Abelmoschus esculentus*. – Applied Soil Ecology 7: 39-46.

[20] Rudresh, D. L., Shivaprakash, M. K., Prasad, R. D. (2005): Effect of combined application of *Rhizobium*, phosphate solubilizing bacterium and *Trichoderma* spp. On growth, nutrient uptake and yield of chickpea (*Cicer aritenium* L.). – Applied Soil Ecology 28: 139-146. https://doi.org/10.1016/j.apsoil.2004.07.005.

[21] Soltani, A., Khavazi, K., Asadi-Rahmani, H., Omidvari, M., Abaszadeh, P., Mirhoseyni, H. (2010): Plant growth promoting characteristics in some *Flavobacterium* spp. isolated from soils of Iran. – Journal of Agricultural Science 4: 106-115. http://dx.doi.org/10.5539/jas.v2n4p106.

[22] Theuretzbacher, F., Lizasoain, J., Menardo, S., Nilsen, P. J., Gronauer, A., Bauer, A. (2014): Effect of steam explosion pretreatment on the specific methane yield of Miscanthus x giganteus. – Agriculturae Conspectus Scientificus 79(1): 19-22.

[23] Wang, Y. H., Yuan, Y., Yang, X. Q., Wang, J. M., Guo, J., Lin, Y. (2016): Comparison of the colloidal stability, bioaccessibility and antioxidant activity of corn protein hydrolysate and sodium caseinate stabilized curcumin nanoparticles. – Journal of food Science and Technology 53(7): 2923-2932. https://doi:10.1007/s13197-016-2257-1.

[24] Wilhelm, W. W., Johnson, J. M. F., Hatfield, J. L., Voorhees, W. B., Linden, P. R. (2004): Crop and soil productivity response to corn residue removal. – Agronomy Journal 96: 1-17. https://doi:10.2134/agronj2004.1000.

[25] Zaller, J. G. (2007): Vermicompost as a substitute for peat in potting media: Effects on germination, biomass allocation, yields and fruit quality of three tomato varieties. – Science Horticulture 112: 191-199. https://doi:10.1016/j.scienta.2006.12.023.
[26] Zubillaga, M. M., Aristi, J. P., Lavado, R. S. (2002): Effect of phosphorus and nitrogen fertilization on sunflower (*Helianthus annuus* L.) nitrogen uptake and yield. – Journal of Argonomy and Crop Science 188: 267-274. https://doi.org/10.1046/j.1439-037X.2002.00570.x.