International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 4, No. 4, p. 41-48, 2014

RESEARCH PAPER OPEN ACCESS

Study effects of bio-fertilizers, nitrogen fertilizer and farmyard manure on yield and physiochemical properties of soil in lentil farming

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Key words: Farmyard manure, nitroxin, nitrogen, lentil, soil.

http://dx.doi.org/10.12692/ijb/4.4.41-48 Article published on February 20, 2014

Abstract

In order to study effects of biological, manure and chemicals nitrogen fertilizer application in lentil farming on physiochemical properties of soil an experiment in randomized complete block design with three replications during 2012 was conducted. Factors of experiment were consisting F1: control, F2: 25 kg/ha nitrogen, F3: 25 ton/hectare cow manure, F4: 25 ton/hectare sheep manure, F5: 25 kg/ha nitrogen + 25 ton/hectare cow manure, F6: 25 kg/ha nitrogen fertilizer + 25 ton/hectare sheep manure, F7: bio-fertilizers, F8: 25 kg/ha nitrogen + bio-fertilizers, F9: 25 ton/hectare cow manure + bio-fertilizers, F10: 25 ton/hectare sheep manure + bio-fertilizers, F11: 25 kg/ha nitrogen + 25 ton/hectare cow manure + bio-fertilizers and F12: 25 kg/ha nitrogen fertilizer + 25 ton/hectare sheep manure + bio-fertilizers. Studied traits were amounts of saturated pH, EC, NH4, NO3, N, K, P, OM, Cu, Zn, Fe, Mn, grain yield and biomass yield. With attention to results of this study, effect of applied treatments had significant and positive effect in more traits.

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Introduction

Lentil is one of the major legumes crops in all over the world including Iran. It is a cheap source of high quality protein in the diets of millions in developing countries, who cannot afford animal protein for balanced nutrition and also rich in important vitamins, minerals, soluble and insoluble dietary fiber. Different lens genotypes showed some genetic variation for plant height, number of branch, number of pod per plant, number of seed per plant and yield. Chemical composition of lens crops can vary with cultivars, soil and climatic conditions of the area (Karadavut and Palta, 2011). Organic agricultural practices aim to enhance biodiversity, biological cycles and soil biological activity so as to achieve optimal natural systems that are socially, ecologically and economically sustainable (Samman *et al.,* 2008). Manure has always been considered as a valuable input to the soil for crop production. In a broad sense, manure management relates to the appropriate use of animal manure according to each farm's capabilities and goals while enhancing soil quality, crop nutrition, and farm profits. Manure management is defined as a decision-making process aiming to combine profitable agricultural production with minimal nutrient losses from manure, for the present and in the future (Karmakar *et al.,* 2007).

Soil quality mainly depends on the response of soil to different land use systems and management practices, which may often modify the soil properties and hence soil productivity (Gurumurthy *et al.,* 2009). Sustainable agriculture involves successful management of resources for increased agricultural production to satisfy changing human needs, while maintaining or enhancing the environment and natural resources. Soil organic matter plays key role in maintainability of soil fertility and productivity. The effect of the organic mater may be either direct or indirect. Organic matter acts directly as a source of plant nutrients and indirectly influences the physical and chemical properties. Farming practices, which involve heavy application of chemical fertilizers, may cause depletion of certain nutrients in soil and certain others would generally accumulate in excess resulting in nutrient imbalance, which affects soil productivity (Son *et al.,* 2004). One of the best ways to maximize organic matter in soils is application of organic manures. Organic manure, apart from supplying Nitrogen (N) and other nutrients, it increases available moisture content of soils, moderates soil acidification resulting from repeated application of NPK fertilizers, improved soil bulk density, higher levels of carbon dioxide in plant canopy, increase buffering capacity against drastic change in PH, complexation of A13+ thereby reducing its toxicity, improves soil aeration and beneficial microbial activities, increase caution exchange capacity of the soil (Tisdale *et al.,* 1985). Excessive application of chemical nitrogen fertilizer can result in a high soil nitrate concentration after crop harvest (Jokela and Randall, 1989; Roth and Fox, 1992; Gordon *et al.,* 2004). 8-9-10. This situation can lead to an increase in the level of nitrate contamination of potable water, because nitrate remaining in the soil profile may leach to groundwater (Sing *et al.,* 1995). A great way to solve these problems is usage of biological nitrogen fixation. The utilization of biological nitrogen fixation method can decrease the use of chemical nitrogen fertilizer (urea), prevent the depletion of soil organic matter and reduce environmental pollution to a considerable extent (Choudhury and Kennedy, 2004). Several bacteria that are associated with the roots of crop plants can induce beneficial effects on their hosts and often are collectively referred to as PGPR (Plant Growth Promoting Rhizobacteria) (Vermeiren *et al.,* 1999). The biological fixation of nitrogen produced by these organisms can constitute a significant and ecologically favorable contribution to soil fertility (Vlassak *et al.,* 1992). Nitroxin is a biologic nitrogen fertilizer containing Azospirillum and Azotobacter. Azospirillum belongs to family Spirilaceae, heterotrophic and associative in nature. In addition to their nitrogen fixing ability of about 20 to 40 kg/ha, they also produce growth regulating substances (Arun, 2007). Although there are many species under this genus like, Azospirillum amazonense, Azospirillum halopraeferens, Azospirillum brasilense, but, worldwide distribution and benefits of inoculation have been proved mainly with the

Azospirillum lipoferum and A. brasilense. Azotobacter belongs to family Azotobacteriaceae, aerobic, free living and heterotrophic in nature. Azotobacters are present in neutral or alkaline soils and A. chroococcum is the most commonly occurring species in arable soils. Azotobacter vinelandii, Azotobacter beijerinckii, Azotobacter insignis and Azotobacter macrocytogenes are other reported species. The number of Azotobacter rarely exceeds of 104 to 105 g-1 of soil due to lack of organic matter and presence of antagonistic microorganisms in soil (Subba, 2001). The bacterium produces anti-fungal antibiotics which inhibits the growth of several pathogenic fungi in the root region thereby preventing seedling mortality to a certain extent (Sheraz Mahdi *et al.,* 2010). Among available means to achieve sustainability in agricultural production, organic manure and bio-fertilizer play an important and key role because they possesses many desirable soil properties and exerts beneficial effect on soil physical, chemical and biological characteristics. The aim of the present study was to test the effects of application bio-fertilizers, nitrogen fertilizer and farmyard manure on grain yield, biological yield and Physiochemical Properties of Soil in Lentil Farming.

Materials and methods

Materials

For study effects of biological, manure and chemicals nitrogen fertilizer application in lentil farming on physiochemical properties of soil an experiment in randomized complete block design with three replications during 2012 was conducted. The study was carried out in Deylaman region (north of Iran) located longitudes 49°48'19" E and latitudes 49° 57'51"N in south of Caspian Sea. The location of study area was showed in figure 1. The factors of experiment were consisting of F1: control, F2: 25 kg/ha nitrogen, F3: 25 ton/hectare cow manure, F4: 25 ton/hectare sheep manure, F5: 25 kg/ha nitrogen + 25 ton/hectare cow manure, F6: 25 kg/ha nitrogen fertilizer + 25 ton/hectare sheep manure, F7: biofertilizers, F8: 25 kg/ha nitrogen + biofertilizers, F9: 25 ton/hectare cow manure + biofertilizers, F10: 25 ton/hectare sheep manure + biofertilizers, F11: 25 kg/ha nitrogen + 25 ton/hectare cow manure + biofertilizers and F12: 25 kg/ha nitrogen fertilizer + 25 ton/hectare sheep manure + biofertilizers. Chemical pure nitrogen was prepared from source of urea fertilizer (46% pure nitrogen).

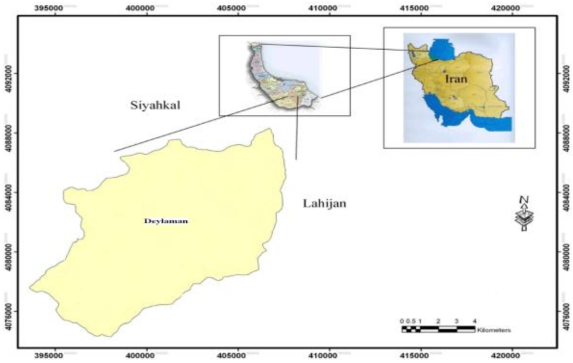

Fig. 1. Location of the study area.

Method to calculate physiochemical properties

Studied traits were amounts of saturated mud acidity (pH), electrical conductivity (EC), ammoniac nitrogen (NH4), nitrate nitrogen (NO3), total nitrogen (N), potassium (K), phosphorus (P), organic matter (OM), copper (Cu), zinc (Zn), iron (Fe), manganese (Mn), grain yield and biological yield. The processed soil samples were analyzed for basic soil parameters (pH, EC and OM) and for macronutrients (N, P, K) by using standard procedures (Jackson, 1973). The available Fe, Mn, Cu and Zn in soil samples were extracted with a DTPA solution (0.005M DTPA + 0.01 M CaCl2 + 0.1M triethanolamine, pH 7.3 as outlined by Lindsay and Norvell (Lindsay and Norvell, 1978). The concentration of micronutrients in the extract was determined by atomic absorption spectrophotometer (ECIL, AAS-4129). At maturity, plants from 1 m2 in the middle of each plot were harvested and grain yield per unit area and grain yield per unit area were determined. The data was analyzed using SAS software. The Duncan's multiple range tests (DMRT) was used to compare the means at 5% of significant.

Result and discussion

Grain yield

According to variance analysis table (Table 1), the effect of biofertilizers, nitrogen fertilizer and farmyard manure application showed significant differences at 1% probability level on grain yield of lentil. The highest grain yield were recorded from F9 (6381 kg/ha), F10 (6627 kg/ha), F11 (6791 kg/ha) and F12 (6915 kg/ha) treatments. The lowest grain yield was recorded from F1 (4150 kg/ha) treatment (Table 2). Similar findings were also reported by sultan (2009) and akbari *et al.* (2011). According to variance analysis table (Table 1), the effect of biofertilizers, nitrogen fertilizer and farmyard manure application showed significant differences at 1% probability level on grain yield of lentil. The highest grain yield were recorded from F11 (1524 kg/ha) and F12 (1551 kg/ha) treatments. The lowest grain yield was recorded from F1 (1212 kg/ha) treatment (Table 2). Similar findings were also reported by sultan (2009) and akbari *et al.* (2011). Nitrogen, a plant nutrient is required by plants in comparatively larger amounts than other elements. Nitrogen is essential component of many compounds of plant, such as chlorophyll, nucleotides, proteins, alkaloids, enzymes, hormones and vitamins. For an optimal yield, the N supply must be available according to the needs of the plant. Nitrogen deficiency generally results in stunted growth, chlorotic leaves because lack of N limits the synthesis of proteins and chlorophyll. This leads to poor assimilate formation and results in premature flowering and shortening of the growth cycle. The presence of N in excess promotes development of the above ground organs with relatively poor root growth. Synthesis of proteins and formation of new tissues are stimulated, resulting in abundant dark green (high chlorophyll) tissues of soft consistency. This increases the risk of lodging and reduces the plants resistance to harsh climatic conditions and to foliar diseases.

Table 1. Results of variance analysis for effects of bio-fertilizers, nitrogen fertilizer and farmyard manure on studied traits.

Source of variance	DF	Grain Yield	pH	EC	NH_4	NO_3	N	K
		Ms						
Replication	2	472034	0.4647	0.0130	139.24	103.283	0.0003	8867.46
Irrigation (I)	11	32787**	0.0037	0.0319*	90.796	131.746**	0.00007*	3279.11*
Error	22	790.08	0.0022	0.006	49.12	127.368	0.00004	4138.86
Source of variance	DF	Biomass Yield	P	OM	Cu	Zn	Fe	Mn
		Ms						
Replication	2	8803964	7.3896	0.0216	0.0301	0.0016	0.0266	0.5153
Irrigation (I)	11	2049866**	30.2083**	0.0116*	0.0056**	0.0061*	0.2194*	0.2156*
Error	22	111831.9	7.2874	0.0045	0.0311	0.0025	0.1123	0.0978

ns,* and **: non significant, significant at the 5 and 1% level of probability respectively.

Physiochemical properties

With attention to variance analysis table (Table 1), the effect of bio-fertilizers, nitrogen fertilizer and farmyard manure application on nitrate nitrogen, phosphorus, and copper showed significant differences at 1% probability level and the effect of bio-fertilizers, nitrogen fertilizer and farmyard manure application on electrical conductivity, total nitrogen, potassium, organic matter, manganese zinc, iron and manganese showed significant differences at 5% probability level and on other measured traits was non significant. Similar result was reported by Keshavarz *et al.* (2012). Chavan *et al.* (2007) reported that the physicochemical properties of the soil improved significantly by the addition of organic manures and that there was very little change due to inorganic fertilizers.

Comparison of means between studied traits showed in table 2. The highest electrical conductivity was recorded from F4, F5, F6, F7, F8, F11 and F12 treatments. The lowest electrical conductivity was recorded from F10 treatment (Table 2). The highest nitrate nitrogen was recorded from F11 and F12 treatments. The lowest nitrate nitrogen was recorded from F1, F2, F7 and F8 treatments (Table 2). The highest potassium was recorded from F3, F4, F5, F6, F8, F9, F10, F11 and F12 treatments. The lowest potassium was recorded from F1 and F2 treatments (Table 2). The highest phosphorus was recorded from

F11 and F12 treatments. The lowest phosphorus was recorded from F1 treatments (Table 2). The highest organic matter was recorded from F3, F4, F5, F6, F7, F8, F9, F10, F11 and F12 treatments. The lowest organic matter was recorded from F1 and F2 treatments (Table 2). The highest copper was recorded from F11 treatments. The lowest copper was recorded from F1 treatments (Table 2). The highest zinc was recorded from F3, F4, F5, F9, F10, F11 and F12 treatments. The lowest zinc was recorded from F1, F2 and F7 treatments (Table 2). The highest iron was recorded from F4, F6, F10, and F12 treatments. The lowest iron was recorded from F1, F2, F3, F5, F7, F8, F9 and F11 treatments (Table 2). The highest manganese was recorded from F3, F4, F5, F6, F8, F9, F10, F11 and F12 treatments. The lowest manganese was recorded from F1 treatments (Table 2).

Table 2. Comparison of mean effect of studied treatments on measured traits.

Treatment	Grain Yield	PH	EC	NH_4	NO_3	N	K
F1	4150G	8.17A	0.45BC	31.99A	33.27E	0.065B	365.41C
F2	5075F	8.06A	0.44BC	36.44A	34.14E	0.068B	369.03C
F3	5385EF	8.05A	0.47BC	40.11A	39.56DE	0.071AB	403.63ABC
F4	5711DE	8.04A	0.59AB	40.51A	40.52CDE	0.072AB	424.43ABC
F5	6153CD	8.06A	0.49ABC	42.65A	47.06ABCD	0.078A	410.17ABC
F6	6242BCD	8.04A	0.49ABC	42.34A	49.42ABC	0.080A	454.04AB
F7	5249EF	8.03A	0.63A	36.21A	37.27E	0.070AB	391.62BC
F8	5321EF	8.04A	0.59AB	39.73A	39.06DE	0.070AB	401.96ABC
F9	6381ABC	8.05A	0.46BC	40.77A	40.71CDE	0.073AB	414.27ABC
F10	6627ABC	8.07A	0.42C	41.75A	42.24BCDE	0.076AB	463.31A
F11	6791AB	8.06A	0.49ABC	47.91A	51.24AB	0.080A	421.58ABC
F12	6915A	8.04A	0.54ABC	53.36A	53.83A	0.080A	465.93A
Treatment	Biomass Yield	P	OM	Cu	Zn	Fe	Mn
F1	1212F	7.47D	0.55C	0.71E	0.14C	0.39B	2.62C
F2	1284E	8.00D	0.59BC	0.72DE	0.14C	0.50B	2.90BC
F3	1345D	13.29ABC	0.62ABC	0.78BC	0.22ABC	0.58B	3.08ABC
F4	1349D	11.45BCD	0.72AB	0.73CDE	0.18ABC	0.91AB	3.27AB
F5	1403C	13.48AB	0.62ABC	0.79B	0.25AB	0.66B	3.13ABC
F6	1446BC	11.74BCD	0.72AB	0.76BCDE	0.18BC	0.93AB	3.36AB
F7	1299ED	8.21CD	0.61ABC	0.72DE	0.15C	0.52B	2.92BC
F8	1319DE	9.42BCD	0.61ABC	0.73CDE	0.17BC	0.53B	2.99ABC
F9	1469B	16.94A	0.64ABC	0.80B	0.25AB	0.69B	3.22AB
F10	1471B	11.84BCD	0.74A	0.76BCDE	0.18ABC	0.93AB	3.47AB
F11	1524A	17.05A	0.70AB	0.86A	0.28A	0.71B	3.26AB
F12	1551A	11.91BCD	0.73A	0.78BCD	0.21ABC	1.37A	3.58A

Within each column, treatments that carry the same superscript letter are not significantly different at $P<0.05$.

Keshavrz *et al.* (2012) with Study Effects of Biological, Manure and Chemicals Nitrogen Fertilizer Application under Irrigation Management in Lentil Farming on Physiochemical Properties of Soil were reported that, among biological nitrogen fertilizer nitroxin application levels, the maximum values of nitrate nitrogen with 46.30, total nitrogen with 0.074%, phosphorus with 13.12 ppm, organic matter with 0.67%, copper with 0.74 ppm, zinc with 0.21 ppm and manganese with 3.21 ppm were found from inoculated level with biological nitrogen fertilizer nitroxin. Also, the minimum values of nitrate nitrogen with 36.81, total nitrogen with 0.068%, phosphorus with 9.82 ppm, organic matter with 0.59%, copper with 0.72 ppm, zinc with 0.16 ppm and manganese with 2.93 ppm were recorded from no inoculated level. Similar results were obtained by Roger and Ladha, (1992); Wani and Lee, (1995). Keshavrz *et al.* (2012) with Study Effects of Biological, Manure and Chemicals Nitrogen Fertilizer Application under Irrigation Management in Lentil Farming on Physiochemical Properties of Soil were reported that, between chemical and manure nitrogen fertilizer management levels, the highest amounts of electrical conductivity with 0.62 ds/m, nitrate nitrogen with 50.31, total nitrogen with 0.08%, potassium with 473.73 ppm, organic matter with 0.72%, iron with 0.99 ppm and manganese with 3.57 ppm were obtained by application of 25 kg/ha nitrogen + sheep manure application treatment. The lowest amounts of electrical conductivity with 0.42 ds/m were recorded from cow manure treatment. The minimum values of nitrate nitrogen, total nitrogen, potassium, organic matter, iron and manganese respectively with 34.76, 0.064%, 356.03 ppm, 0.57%, 0.43 ppm and 2.62 ppm were obtained from control treatment (without use of chemical nitrogen, cow and sheep manure). The maximum amount of saturated mud acidity was obtained from control treatment with 8.19 and the minimum amount of this trait jointly was recorded from 25 kg/ha nitrogen + cow manure and also from 25 kg/ha nitrogen + sheep manure with 8.15. The highest values of phosphorus with 15.36 ppm, copper with 0.77 ppm and zinc with 0.24 ppm were recorded from application of 25 kg/ha nitrogen + cow manure treatment. Combined application of organic manure and chemical fertilizer improves soil fertility, soil physical and chemical properties (Nyangani. 2010). Keshavrz *et al.* (2012) with Study Effects of Biological, Manure and Chemicals Nitrogen Fertilizer Application under Irrigation Management in Lentil Farming on Physiochemical Properties of Soil were reported that, the lowest values of phosphorus with 8.93 ppm were recorded from control management. Minimum of copper was obtained from 25 kg/ha nitrogen application with 0.69 ppm. Also, the lowest value of zinc with 0.15 jointly was recorded from control and also 25 kg/ha nitrogen fertilizer application treatments. Similar results were found by Joshi *et al.* (1994); Son and Ramaswami (1997).

Conclusion

Farmyard manure and bio-fertilizer are two types of organic amendments that can improve the physical, chemical and biological characteristics of the soils. Analysis of the organic amendments effect on the physical characteristics of the soil revealed a better structural stability when applying bio-fertilizer or manure. In addition, soil permeability was improved due to the presence of an appreciable amount of organic matter associated to an important microbiological activity. Addition of bio-fertilizer or manure acted significantly on the characteristics of the soil, especially on the soil fertility and its productive capacity. Moreover, organic level was improved, resulting in a higher organic carbon content which contributes to diminish climatic heating.

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