International Journal of Agriculture and Crop Sciences.
Available online at www.ijagcs.com
IJACS/2013/5-8/896-899
ISSN 2227-670X ©2013 IJACS Journal

IJACS

Effect of integrated application of a complex fertilizer ($N_{30}P_{50}$) on nitrogen fixation by Lentil (Lens culinarisMedik.)

SeyedSaeid Hojjat[*1] and Abdollah Taherzadeh[2]

1. Ferdowsi University of Mashhad,Mashhad, Iran.
2[*]. Department Food Sciences and Technology, Islamic Azad University, Quchan branch, Iran

Corresponding author email: sdhojjati@yahoo.com

ABSTRACT: Lentil (Lens culinarisMedik.) is an important grain Lentil is known to fix atmospheric nitrogen in the soillegume crop in the world. Nitrogen fixing capability of lentil can be enhanced by the supply of adequate amounts of nutrients, especially phosphorus (P) and nitrogen (N).The fixing is done by bacteria (Rhizobium leguminosarum)that form nodules on the roots of lentils.Genotypes of lentil may showdifferential response to nutrients and combined application of N and P may have synergisticandantagonistic effects on crop yield.Therefore, field experiments were conducted during the crop cycle 2010–11at Chenaran locations, in northern east, Iran,to study the effect of integrated application of nitrogen(0 and 30 kg ha^{-1}) and phosphorus (0 and 50 kg ha^{-1})on nodulation, nitrogen fixation, growth and yield of seven genotypes of lentil.Generally, number and dry weight of nodules and grain yields increased with increasing fertilizer levels.

Key words: lentil, legume, Nitrogen fixing, nodulation, nutrients.

INTRODUCTION

The ability of legumes to fix atmospheric nitrogen is perhaps the most notable aspect that sets them apart from other plants. This can be directly attributed to a legume's ability to supply most of its own nitrogen needs with the help of symbiotic Rhizobia bacteria living in their roots.

Lentil is an important pulse crop in the world, grown in at must countries. Lentil was grown on 170000 ha in Iran during 2009; with anaverage yield were400 kg ha^{-1} which is very low as compared to the, Canada (1400 kg ha^{-1}) and turkey (4100 kg ha^{-1}) and (FAO, 2010).This low yield of the crop in Iran is primarily due to genetic and agronomic factors. From an agronomic point of view, nutritional deficiency is likely to depress its nitrogen–fixing role and may in turn limit crop yield.An adequate supply of mineral nutrients to legumes enhances nitrogen fixation (Ganeshamurthy and Reddy, 2000). For example, starter N stimulated early seedling growth and nodulation (Daramolaet al, 1982).

In many soil types' especially calcareous soils, P is the most limiting nutrient for the production of crops (Jiang et al, 2006). As nitrogen fixing plants, legumes require P for adequate growth and nodulation (Tang et al, 2001a). The influence of phosphorous on symbiotic nitrogen fixation in legumes has received considerable attention, but its role in the process remains unclear (Tsvetkova and Georgiev, 2003). In Iran, research work regarding integrated use of P and N and their role in legume N fixation and nutrient uptake is very scarce. Therefore, the present study was conducted to assess the interactive effect of N and P application on nitrogen fixation by lentil crop under rainfed conditions of Chenaran highland, Iran.

MATERIALS AND METHODS

Field experiments were conducted with lentilat Chenaran locations, in northern east, Iran, during the crop cycle 2010–11. The trial was laid out according to the randomized complete block design with four replications, and sampling was carried out during two harvests in: November and may. There were two treatments with combinations of N rates (0, 30 kg ha^{-1}) and P (0, 50 ha^{-1}). Phosphorus was applied as triple super phosphate (TSP). Lentil crop was sown in first week October, maintaining 30 cm row to row distance. All the fertilizers were applied at the time of sowing. Harvesting was done in the last week of May. Crop from a 0.2 m^2 area in the middle of each plot was harvested separately and data were recorded for seed yield after threshing. Representative samples of 100 g for both straw and grain separately were collected from bulk sample, oven dried, ground and analyzed for N and P (Ryan et al, 2001) Titrate obtained from N determination was concentrated and used for (δ^{15}N measurement by mass spectrometer (Peoples et al., 1989):

% N_{dfa}=100 × (δ^{15}N (soil N) – δ^{15}N legume N)/ (δ^{15}N (soil N)–B)where δ^{15}N (soil N) is commonly obtained from a non N fixing reference plant grown in the same soil as the legume; B is the (δ^{15}N of the same N fixing plant when grown with N as the sole source of N and its value is –2.5 (Shah et al, 1997).

Legume kg N ha^{-1} = legume total biomass kg ha^{-1} × % N in plant

kg N fixed ha^{-1}=legume kg N ha^{-1}× % N_{dfa} × I.5*

*1.5 factor was used to include an estimate for contribution by underground N (Peoples et al., 1989).Data on all observations were subjected to analysis of variance (ANOVA) using the software MSTATC. Treatment means were compared by orthogonal contrasts (three replications).

RESULTS AND DISCUSSIONS

There was a significant interaction between N and P on seed yield at lentil (Table 1).Increase in seed yield due to P application is similar to those found by Hayat (2005). Adequate P nutrition enhances many aspects of plant physiology including photosynthesis, flowering, fruiting and maturation (Brady and Weil, 2005). Regarding % N_{dfa}, similar results were recorded at both locations (Table 1). The main effect of P as well as P by N interaction was significant on % $N_{dfa.}$ Difference between P_1 and P_2 was significant at lentil. Increase in N fixation due to P application is comparable to those reported by Somadoet al. (2006). Phosphorous application affected total N accumulated rather than % N_{dfa}, which was due to an increase in growth of host plant due to P application rather than direct involvement of P in N fixation.Application of P (50 kg ha^{-1}) increased N fixation by 100 %.Phosphorus fertilization of legume species leads to increased nitrogenase activity, nodule number, nodule mass and plant N accumulation (Shu–Jieet al., 2007). Increase in N uptake was to a better plant growth. Root growth, and particularly development of lateral roots and fibrous rootlets, is encouraged by addition of P (Lopez–Bucioetal, 2002). Adequate P nutrition enhances many aspects of plant physiology including photosynthesis (Brady and Weil, 2005). This leads to increased N assimilation, and as a result, increased N uptake by the plant.Increased N uptake may also be due to increased protein synthesis and subsequent photosynthesis (Sexton et al., 1998). Phosphorus application not only increased biomass production but also increased P concentration in plant tissue (Shu–Jieet al, 2007).Resulted show that application of N and P increased uptake of these nutrients from soil.

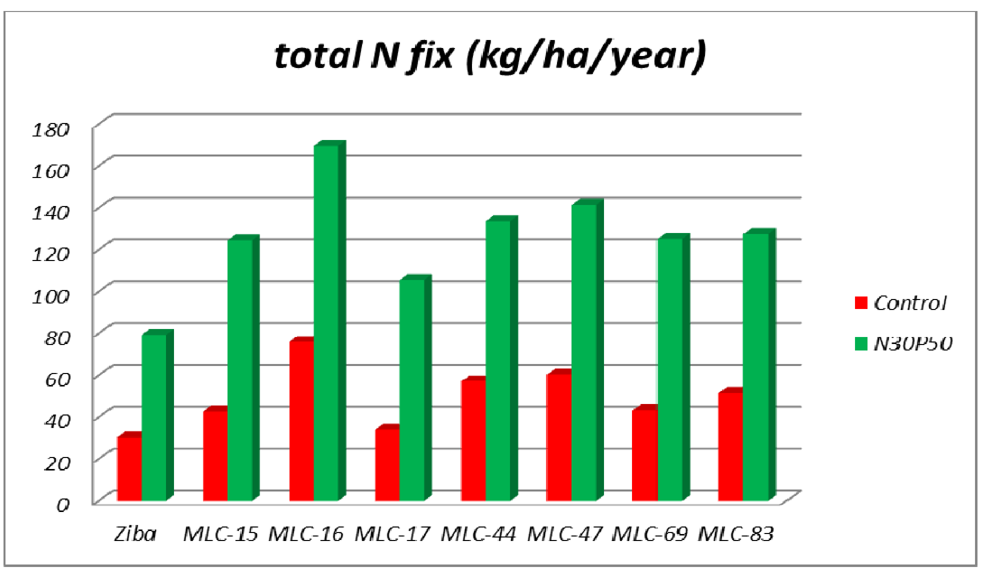

Figure 1.The difference in the content of N in the soil

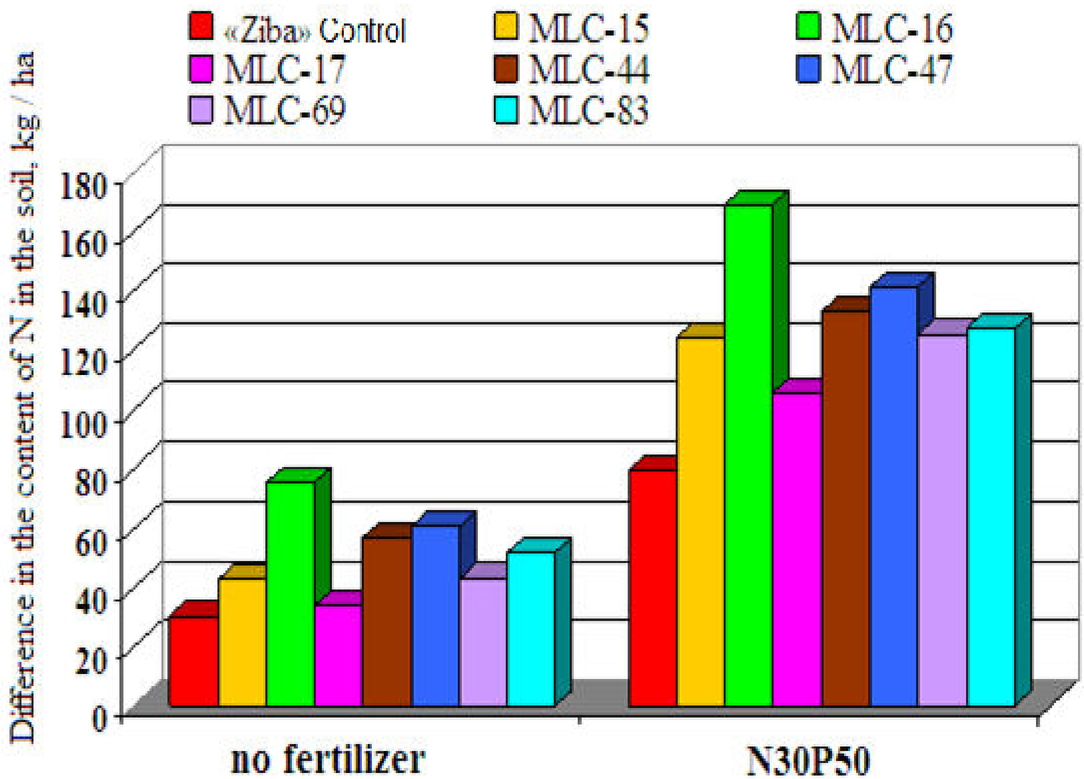

Figure 2. The fixed biological nitrogen investigated accessions of lentil

Table 1.Effect of Nitrogen and Phosphorus on nodulation, yield and N yield of lentil.

genotyp	nodule dry weight (mg)		shoot dry weight (g)		N plant total nitrogen (kg/ha)		N grain yield(kg/ha)		TotalN (kg/ha/year)		total N fix (kg/ha/year)	
	Control	$N_{30}P_{50}$	Control	$N_{30}P_{50}$	Control	$N_{30}P_{50}$	Control	$N_{30}P_{50}$	Control	$N_{30}P_{50}$	Control	$N_{30}P_{50}$
Ziba	7.8	18	1.7	3.4	41.8	124	4.14	24.9	37.66	99.1	30.128	79.28
MLC-15	9.71	21.7	2.22	5.45	64.8	224	11.37	68.45	53.43	155.55	42.744	124.44
MLC-16	15.45	30.4	3.09	6.28	108.6	295	13.83	83.19	94.77	211.81	75.816	169.448
MLC-17	8.75	19.9	2.04	5.14	52.4	193	10.16	61.15	42.24	131.85	33.792	105.48
MLC-44	13.46	27.7	2.82	5.82	83.8	242	12.55	75.35	71.25	166.65	57	133.32
MLC-47	13.92	27.9	2.84	5.91	88.4	254	12.81	77.12	75.59	176.88	60.472	141.504
MLC-69	10.39	22	2.25	5.53	65.9	227	11.76	70.59	54.14	156.41	43.312	125.128
MLC-83	12.19	25.2	2.57	5.58	76.1	231	11.92	71.67	64.18	159.33	51.344	127.464

CONCLUSION

Application of N and P significantly increased seed yield, N fixation and N uptake at the Chenaran locations. The effect of Nand P on % N_{dfa} was significant.It was observed that P application increased total N uptake, which contributed towards an increase in N fixation. Thus, the effect of P application on N fixation was indirect.Application of both N and P increased nutrient uptake, which may improve the quality of produce.

REFERENCES

Brady NC, Weil RR. 2005. The Nature and Properties of Soils. 13th Ed. Pearson education, Singapure. P 976.

Daramola DS, Adebayo A, Odeyemi O. 1982. Effect of herbicide application on legume Rhizobium symbiosis with and without starter nitrogen. TurrialbaJ 32: 315–320.

FAO, Food and Agricultural Organization. 2010. http://faostat. fao. org/site/ 567/ Desktop Default. aspx?PageID=567.

Ganeshamurthy AN, Reddy KS. 2000. Effect of integrated use of farm yard manure and sulphur in soybean and wheat cropping system on nodulation, dry matter production and chlorophyll content of soybean on swell shrink soils in Central India. Agronomy and Crop ScienceJ 185: 191–197.

Hayat R. 2005. Sustainable legume cereal cropping system through managemnt of biological nitrogen fixation in pothwar. Ph.D. thesis, University of Arid Agriculture Rawalpindi. P 161.

Jiang D, Hengsdijk H, Dai TB, de Boer W, Jing Q, Cao WX. 2006. Long term effect of manure and inorgainc fertilizer on yield and soil fertility for a winter wheat– maize system in Jiangsu, China. PedosphereJ 16: 25–32.

López–Bucio J, Hernández–Abreu E, Sánchez–Calderón L, Nieto–Jacobo MF, Simpson J, Herrera–Estrella L. 2002. Phosphate availability alters architecture and causes changes in hormone sensitivity in the Arabidopsis root system. Plant Physiology J 129:244–256.

Muhammad I, Safdar A. 2009. Effect of integrated application of sulphur and phosphorus on nitrogen fixation and nutrient uptake by Chickpea (CicerarietinumL.). Agrociencia J 43(8): 815-826.

Peoples MB, Faizah AW, Rekasem B, Herridge DF. 1989. Methods for evaluating nitrogen fixation by nodulated legumes in the field. Monograph J 11: 22–45.

Ryan J, Estefan G, Rashid A. 2001. Soil and Plant Analysis Laboratory Manual. International Centre for Agricultural Research in Dry Areas. (ICARDA) Allepo, Syria,

Sexton PJ, Peak NC, Shibles R. 1998. Soybean sulphur and nitrogen balance under varying levels of available sulphur. Crop Sci J 38: 975–982.

Shah Z, Shah SH, People MB, Herridge DF. 1997. Surveys of N fixation of lentil, mung bean and black gram in farmer's field in North West Frontier Province, Pakistan. In: Extending nitrogen fixation research to farmers field: Proc. Int. workshop on Managing legume nitrogen fixation in the cropping systems of Asia, 20–24 Aug, 1996, ICRISTAT Asia Centre, India, Patancheru 502 324, Andhra Pradesh, India pp: 333–341.

Shu–Jie M, Yun–Fa Q, Xiao– Zeng H, AN M. 2007. Nodule formation and development in soybean (Glycine max L.) response to phosphorus supply in solution culture. PedosphereJ 17(1): 36–43.

Somado EA, Sahrawat KL, Kuehne RF. 2006. Rock phosphate–P enhances biomass and nitrogen accumulation by legumes in upland crop production systems in humid West Africa. Biology And Fertility Of Soils J 43:124–130.

Tang C, Hinsiger PJ, Drevon JJ, Jaillard B. 2001a. Phosphorus deficiency impairs early nodule functioning and enhances proton release in roots of MedicagotruncatulaL. Annals of Botany is an international plant science J 88: 131–138.

Tsvetkova GE, Georgiev GI. 2003. Effect of phosphorus nutrition on the nodulation, nitrogen fixation and nutrient use efficiency of Bradyrhizobiumjaponicum– soybean (Glycine max L. Merr) symbiosis. Bulgaria PlantPhysiology J pp:331–335.