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Evaluation Of Wheat And Lentil Mixed Cropping Based On Crude Protein Concentration

Sadullah N. AL-NIEMI and Shukri I. REKANI*

University of Mosul, College of Agriculture and Forestry, Department of Soil and Water Sciences, MOSUL, IRAQ

Corresponding Author: Shukri I. REKANI

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A B S T R A C T

Field experiment was carried out during the winter season of 2012 at the Al-Shalalat village which located at the (43º.12"03.64 E) and (36º.28"04.40 N), Mosul city, Nineveh province of Iraq. The aim was to determine the impact of mixed cropping of wheat with lentil on yield performance and to investigate the best combination and efficiency of resource utilization by determining crude protein-land equivalent ratio (protein LER). Mixed cropping resulted in reduced yields of both wheat and lentil as compared to sole cropping. Further results based on the analysis of grain quality showed that crude protein concentration of the mixed crop wheat was increased compared to wheat sole crop, but was estimated lower than in sole and mixed crop grain lentil. The highest performance on Nitrogen, crude protein concentrations and protein LER in wheat grain was achieved in mixed cropping treatment [T5: wheat (100 kg ha^{-1}) + lentil (80 kg ha^{-1})], but in order to assess better the mixed cropping profitability concerning economical aspect in dry areas of Iraq, this study showed that a wheat (100 kg ha^{-1}) + lentil (40 kg ha^{-1}) mixture can gave the highest grain yield with maximal N and wheat grain crude protein content, leading to higher protein LER than other planting ratio and sole cropping

Keywords: *crud protein, lentil, mixed cropping, wheat.*

INTRODUCTION

The major factors lowering cereal productivity in many agricultural areas in Nineveh province (wheat growing area of the northern Iraq) are the combination of high soil pH (7.6 – 8.2), $CaCO_3$ (370 g kg^{-1}) and heavy soil texture together with low levels of organic matter and soil moisture (Arid and semiarid land farming). Urbanization and industrialization due to the global population explosion decrease gradually the cultivable area, which facing pressure to meet basic demands for food especially in the developing countries of Asia and Africa .Therefore, there is need for not only increase production, but also the ability to grow multiple crops in small areas. Mixed cropping system which define growing two or more species or cultivars on the same piece of land during the same season is known to increase the size and stability of yields through the effective utilization of natural resources (Hauggaard – Nielsen, 2006; Li, 1999 and 2001; Zhang and Li., 2003**)** compared to mono cropping. It is used in many parts of the world for the production of food and feed crops to share the food demand which is one of the of the most important problems of the world is enduring nowadays, improvement of soil fertility through the addition of nitrogen by fixation and extraction from the component legume and increasing the availability of nutrients in the soil rhizosphere (Hauggaard-Nielsen and Jensen 2001). Legume/cereal intercropping is one of the most common practices and has been popular in rain-fed areas of the world due to its low cost of production and high monetary returns to the farmers (Ofori and Stern, 1987), improving yield stability, socio-economic and some other advantages (Willey, 1979). Intercropping yield advantage systems has been well documented during the past decades. However, studies on the effect of interspecific root interactions on nutrients including N

advantage still need to be further enhanced. One parameter such as crude protein concentration has been used to assess the efficiency of mixed crops. In this research the wheat and lentil mixed crops was tested in regard to grain yield and crude protein compared to sole cropping. Thus the aim of our study to determine the best combination and efficiency of resource utilization by determining crude protein-land equivalent ratio (protein LER).

MATERIALS AND METHODS

Crop management and experimental design

Field experiment was conducted during 2012 in a private farm in Al-Shalalat village – Mosul city, Nineveh province of Iraq. The topsoil (0–0.3m) of the experimental field was a clay loam with a composition of 452 g kg^{-1}clay, 450 g kg^{-1} silt and 98 g kg^{-1} sand. The pH of the soil was 7.83. The air-dried soil contained 56 mg kg-1available N, 20.4 g kg^{-1}organic matter and 370 g kg^{-1} $CaCO_3$. The experiment was arranged as a factorial based on randomized complete block design (split plot) with three replications. The following treatments were used :

T1 : Sole wheat (100 kg ha^{-1}) + (0.0 kg ha^{-1}) Lentil
T2 : Wheat (100 kg ha^{-1}) + (20 kg ha^{-1}) Lentil
T3 : Wheat (100 kg ha^{-1}) + (40 kg ha^{-1}) Lentil
T4 : Wheat (100 kg ha^{-1}) + (60 kg ha^{-1}) Lentil
T5 : Wheat (100 kg ha^{-1}) + (80 kg ha^{-1}) Lentil
T6 : Sole Lentil (0.0 kg ha^{-1}) wheat + (80 kg ha^{-1}) Lentil

Six blocks were used, each block size was 3.6 m×100 m involving 20 rows with inter–row spacing of 18 cm and inter-block spacing of 1.5 m. Seed bed preparation included ploughing, disk harrowing and cultivation. Seed rate used for wheat was 100 kg ha^{-1} and 80 kg ha^{-1} for lentil. Irrigation water was provided when needed using sprinkler irrigation.

Calculation of LER

After harvest and in order to evaluate the competitive effects among component crops and to determine mixed cropping performance in mixture and sole crop, different indices as grain yield and crude protein concentration of both wheat and lentil of each treatment were calculated .The basic tool that some of the agricultural scientists generally use to evaluate mixed crop efficiencies is the crude protein concentration and its protein LER**.** The crops were harvested at maturity stage, in June. After threshing, the grain dry matter yield was determined. The assessment of plant crude protein concentration in the dry grain was determined by the Kjeldahl method, multiplying it by 6.25 for legume grain or 5.7 for wheat grain. In particular, LER verifies the effectiveness of mixed cropping for using the resources of the environment compared to sole cropping (Mead and Willey, 1980; Dhima, 2007).

When LER is greater than 1, the mixed cropping favors the crude protein concentration of the species. In contrast, when LER is lower than 1, the mixed cropping negatively affects the crude protein concentration of plants grown in mixtures (Ofori and Stern, 1987; Caballero, 1995; Dhima, 2007). Protein LER values was calculated according to Willey (1979) using the following formula: LER = (LER wheat + LER lentil), where LER wheat = (Ywm /Yws), and LER lentil = (Ylm / Yls), where Yws and Yls are the crude protein concentrations of wheat and lentil as sole crops, respectively, and Ywm and Ylm are the crude protein concentrations of wheat and lentil as mixed crops, respectively.

Statistical analysis procedure

A randomized complete block design (split plot) was used for the statistical analysis of the data. The treatment means were compared by determining the least significant difference (LSD) at 5% level of probability (P =0.05) using statistical analysis software SAS (2002).

RESULTS AND DISCUSSION

Yields of crops

The high pH and the high concentration of $CaCO_3$ and clay content in soil (Table-1) of the field experiment together with low annual precipitation in the area can be considered to be the major factors causing deficiency of the most nutrients specially Phosphorus and micronutrients in wheat and lentil crops grown under the condition of our study, where the nutrients absorption is highly dependent on soil water status and root growth (Mengel and Kirkby, 2001). The results (Tables-2 and 3) showed a yields reduction in mixed cropping treatments of both crops (T2, T3, T4 and T5) as compared to sole treatments (T1and T6). This reduction might be due to the higher competition for moisture, space, light and nutrition among the crop plants, also wheat might had shading effect on lentil (Akter, et al., 2004). These results agrees with the finding of (Yağmur and Kaydan, 2006).

N concentration and crude protein of crops

Although the mixed cropping system in our study reduced the yields of both crops, but it was conferred many advantages and important benefits of legume-cereal mixtures compared to their monocultures. Clearly, one the most important reason for planting two or more crops together is producing a high quality grains of crop rich in protein for human food. The most important criteria for grain quality evaluation is the concentration of crude protein (Sarunaite et al., 2010). Our results based on the analysis of grain quality showed that crude protein concentration of the mixed crop wheat was increased compared to wheat sole crop, but was estimated lower than in sole and mixed crop grain lentil (Tables- 2 and 3). The N and crude protein concentrations in wheat grain yield ranged between 22.5-32.5 g kg^{-1} for nitrogen and 128.25-185.25 g kg^{-1} for crude protein (Table- 2). The highest performance on N and crude protein concentrations in wheat grain was achieved in mixed cropping treatment T5: [Wheat (100 kg ha^{-1}) + Lentil (80 kg ha^{-1})] followed by the mixed cropping treatments T3: [Wheat (100 kg ha^{-1}) + Lentil (40 kg ha^{-1})] T2: [Wheat (100 kg ha^{-1}) + Lentil (20 kg ha^{-1})] and T4: [Wheat (100 kg ha^{-1}) + Lentil (60 kg ha^{-1})] while the lowest N and crude protein concentrations were with the sole treatment T1: Sole wheat (100 kg ha^{-1}). Lentil and wheat can complement each other in the use of nitrogen source in soil, but the nitrogen fixing legume can also capture atmospheric nitrogen. Therefore, grain legume density is important in mixed crop for inorganic nitrogen utilization by cereals for significant nitrogen increasing in grain (Jensen, 1996). Zougmore et al. (2006) stated that legume compensated nitrogen deficiency, due to its high nitrogen fixation capacity. The high ability of legumes for nitrogen fixation is among their most important characters that can reduce needs for applying chemical nitrogen fertilizers. In case of lentil the N and crude protein concentrations in lentil grain yield ranged between 30.0-39.2 g kg^{-1} for nitrogen and 187.50-245.00 g kg^{-1} for crude protein (Table- 3). The highest N and crude protein concentration (Table- 3) were achieved in sole treatment T6: Sole lentil (100 kg ha^{-1}) followed by the mixed cropping treatments T3: [Wheat (100 kg ha^{-1}) + Lentil (40 kg ha^{-1})], T4: [Wheat (100 kg ha^{-1}) + Lentil (60 kg ha^{-1})] and T5: [Wheat (100 kg ha^{-1}) + Lentil (80 kg ha^{-1})] while the lowest N and crude protein concentrations was with the T2 treatment [Wheat (100 kg ha^{-1}) + Lentil (20 kg ha^{-1})].

Protein Land Equivalent Ratio (Protein LER)

The protein LERs in all mixed treatments were more than one (Table- 5). The highest LER in respect of crude protein yield was achieved in mixed cropping treatment T5: [Wheat (100 kg ha^{-1}) + Lentil (80 kg ha^{-1})] followed by the mixed cropping treatment T3: [Wheat (100 kg ha^{-1}) + Lentil (40 kg ha^{-1})], While the lowest protein-LER among the mixed cropping treatments was belonged to T2: [Wheat (100 kg ha^{-1}) + Lentil (20 kg ha^{-1})]. The best combination of wheat-lentil crops in mixture in respect to protein LER was T5: [Wheat (100 kg ha^{-1}) + Lentil (80 kg ha^{-1})]. But in concerning crude protein yield in dry areas of Iraq and to assess better the mixed cropping profitability concerning economical aspect, this study showed that a Wheat (100 kg ha^{-1}) + Lentil (40 kg ha^{-1}) mixture can gave the highest grain yield with maximal N and wheat grain crude protein content, leading to higher protein LER than other planting ratio and sole cropping.

Table 1. Physiochemical properties of top soil sample (0 – 15cm)

1	Soil pH from 1:1 soil suspension	7.83
2	Total Calcium carbonate(g kg^{-1})	370
3	Organic matter (g Kg^{-1})	20.4
4	Sand (g Kg^{-1})	98
5	Silt (g Kg^{-1})	450
6	Clay (g Kg^{-1})	452
7	Soil texture	Clay loam
8	Available Nitrogen (mg Kg^{-1})	56
9	Available phosphorous (mg Kg^{-1})	4.6
10	Available Potassium (mg Kg^{-1})	355.6

Table 2. Effect of mixed cropping wheat with lentil on grain yield, concentration of N and crude protein in wheat grain

Treatments	Grain yield (t ha^{-1})	N (g kg^{-1})	Crude protein (g kg^{-1})
T1:Sole wheat (100 kg ha^{-1})	1.78	22.5	128.25
T2:Wheat (100 kg ha^{-1}) + Lentil (20 kg ha^{-1})	1.63	25.9	147.63
T3:Wheat (100 kg ha^{-1}) + Lentil (40 kg ha^{-1})	1.75	27.5	157.32
T4:Wheat (100 kg ha^{-1}) + Lentil (60 kg ha^{-1})	1.25	25.0	142.50
T5:Wheat (100 kg ha^{-1}) + Lentil (80 kg ha^{-1})	0.98	32.5	185.25
LSD (0.05)	0.24	8.80	50.00

Table 3. Effect of mixed cropping wheat with lentil on grain yield, concentration of N and crude protein in lentil grain

Treatments	Grain yield ($t\ ha^{-1}$)	N ($g\ kg^{-1}$)	Crude protein ($g\ kg^{-1}$)
T2:Wheat (100 kg ha^{-1}) + Lentil (20 kg ha^{-1})	0.26	30.0	187.50
T3:Wheat (100 kg ha^{-1}) + Lentil (40 kg ha^{-1})	0.41	37.5	234.38
T4:Wheat (100 kg ha^{-1}) + Lentil (60 kg ha^{-1})	0.42	37.5	234.38
T5:Wheat (100 kg ha^{-1}) + Lentil (80 kg ha^{-1})	0.47	34.2	213.75
T6:Sole lentil (100 kg ha^{-1})	0.67	39.2	245.00
LSD (0.05)	0.43	23.4	146.06

Table 4. Effect of wheat-lentil mixed cropping on LER of crude protein

Treatment	LER of crude protein
T2:Wheat (100 kg ha^{-1}) + Lentil (20 kg ha^{-1})	1.92
T3:Wheat (100 kg ha^{-1}) + Lentil (40 kg ha^{-1})	2.18
T4:Wheat (100 kg ha^{-1}) + Lentil (60 kg ha^{-1})	2.07
T5: Wheat (100 kg ha^{-1})+Lentil (80 kg ha^{-1})	2.32
LSD(0.05)	0.66

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