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Evaluation of qualitative traits of corn grains under intercropping of corn and bean systems

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ABSTRACT: In order to investigate of intercropping corn and red bean, an experiment as randomized complete block design with 3 replications was conducted on Zanjan university research farm in 2011. The experimental treatments included: T1: monoculture of corn, T2: replacement intercropping system 1:1 ratio (50% of corn + 50% of bean), T3: replacement intercropping system 1:2 ratio (67% of corn + 33% of bean), T4: replacement intercropping system 2:1 ratio (33% of corn + 67% of bean), T5: replacement intercropping system 2:2 ratio (50% of corn + 50% of bean), T6: intercropping additive system with 100% of corn + 5% of bean ratio, T7: intercropping additive system with 100% of corn + 15% of bean ratio, T8: intercropping additive system with 100% of corn + 25% of bean ratio, T9: intercropping additive system with 100% of corn + 35% of bean ratio, T10: monoculture of bean. Results showed that intercropping systems had significant effect on grain qualitative characteristics of corn. For example, intercropping additive system with 100% of corn + 15% of bean ratio treatment had the highest protein content with mean of 10.81%.

***Keywords*:** corn, bean, intercropping system, protein content.

INTRODUCTION

Intercropping is being advocated as a new and improved approach to farming. However, it has been avoided because of the complications of planting and harvesting. Intercropping involves competition for light, water and nutrients. However, intercropping usually benefits from increased light interception, root contact with more soil, increased microbial activity and can act as a deterrent to pests and weeds of the other crop. There is also evidence that suggests intercropping may benefit a non-legume which needs nitrogen if the other crop is a legume, since legumes will fix nitrogen in the soil (Portes, 1984; Avcioglu et al., 2003).

Intercropping of cereals with legumes has been popular in tropics (Hauggaard-Nielsen et al., 2001; Tsubo et al., 2005) and rain-fed areas of the world (Banik et al., 2000; Ghosh, 2004; Agegnehu et al., 2006; Dhima et al., 2007) due to its advantages for soil conservation (Anil et al., 1998), weed control (Poggio, 2005; Banik et al., 2006), lodging resistance (Anil et al., 1998), yield increment (Anil et al., 1998; Chen et al., 2004), hay curing, forage preservation over pure legumes, high crude protein percentage and protein yield (Qamar et al., 1999; Karadag and Buyukburc, 2004), and legume root parasite infections control (Fenandez-Aparicio et al., 2007). Intercropping of corn with legumes is an alternative to monocropping of corn and has a number of advantages such as lower inputs, lower cost of production, and better silage quality than monocropping systems. Therefore, the objectives of the present study was evaluated the effect of intercropping treatments of corn and bean on qualitative characteristics of corn grains.

MATERIALS AND METHODS

Study area and trial procedure

This experiment was conducted in Zanjan university research farm. This experiment was done as randomized complete block design with 3 replications. The study of phosphorus, potassium, nitrogen and protein contents in the grains of *cv*. Maxima was carried out in 2011.

The experimental treatments included:

T1: monoculture of corn,
T2: replacement intercropping system 1:1 ratio (50% of corn + 50% of bean),
T3: replacement intercropping system 1:2 ratio (67% of corn + 33% of bean),
T4: replacement intercropping system 2:1 ratio (33% of corn + 67% of bean),
T5: replacement intercropping system 2:2 ratio (50% of corn + 50% of bean),
T6: intercropping additive system with 100% of corn + 5% of bean ratio,
T7: intercropping additive system with 100% of corn + 15% of bean ratio,
T8: intercropping additive system with 100% of corn + 25% of bean ratio,
T9: intercropping additive system with 100% of corn + 35% of bean ratio,
T10: monoculture of bean.

The soil was harrowed 10 days before planting, after which 100 kg ha^{-1} of N was broadcast and disked to produce a smooth seed bed. After 2 weeks of corn seeding, corn mono cropping plots received an extra 50 kg N ha^{-1} by hand-broadcasting to give a total of 75 kg ha^{-1} in each plot. Corn and bean were simultaneously seeded in June 1. Each plot was 4 m long in which corn was planted by hand in four rows with 75 cm row spacing. Legumes were also sown by hand between each corn rows or on the corn rows in intercropped plots.

Table 1. Physical and chemical properties of experimental soil before planting

Depth (cm)	O.C. (%)	N (%)	P (ppm)	K (ppm)	Texture	pH	EC (ds/m)
0-30	1.21	0.07	14.2	266	Clay-loam	8.18	0.7

Mineral analysis

First, collected grains carefully rinsed with distilled water, and then they were dried by oven at 60 ° C for 24 h. The next step, the grains were ground fine enough to pass a 0.5-mesh screen. After the content extracted by freshwater digestion procedure and analyzed for macronutrient content according to the guidelines of the Association of Official Analytical Chemists (AOAC 1990).

In this regards, The phosphorus was analyzed spectrophotometrically by the phospho-vanadate colorimetric method (Hewlett Packard 8452A, Ontario, Canada); K was determined by flame photometry (Corning 405, Halstead, UK), and nitrogen was determined by Kjeldahl analysis. Crude protein concentrations were calculated by multiplying total N by 6.25. Data are given as % of DW.

Statistical Analysis

The data on quality characteristics were analyzed by Fisher's analysis of variance technique and Duncan test at 0.05 probability level to compare the treatment means (Steel and Torrie, 1984). Data analysis was conducted using of SAS (SAS Institute, 2004) as RCBD with three replicates.

RESULTS AND DISCUSSION

Results of ANOVA revealed that intercropping culture had significant effect on phosphorus content ($P<0.01$) (table 2). The obtained results showed that additive system with 100% corn + 15% of bean ratio treatment with mean of 0.55% had the most phosphorus content in grains and replacement system with 33% corn + 67% bean treatment with mean of 0.27% had least value (figure 1).

The results in Table 2 indicated that potassium content was influenced by intercropping culture treatments at $P<0.01$ level (table 2). The mean comparison of intercropping systems on potassium content indicated that intercropping additive system with 100% of corn + 15% of bean ratio with mean of 0.47% had the highest value and the lowest values belonged to intercropping additive system with 100% of corn + 25% of bean ratio, T9: intercropping additive system with 100% of corn + 35% of bean ratio with means of 0.34% and 0.32%, respectively (figure 2).

Investigation of the variance analysis showed that effect of intercropping was significant on nitrogen content (table 2). The obtained results revealed that intercropping additive system with 100% of corn + 15% of bean ratio treatment had the most nitrogen content with mean of 10.81% (figure 3). Armstrong et al (2008) also reported the feed nutrient value of corn was greater in the corn–bean mixtures compared with monoculture corn.

Effect of intercropping (P<0.01) was significant on protein content (table 2). The results indicated that intercropping additive system with 100% of corn + 15% of bean ratio treatment had the highest protein content with mean of 10.81% (figure 4). Primitive effect of legume intercrops on protein concentration of main crop has also been reported by Mpairwe et al, (2002) and Azraf-ul-Haq et al, (2007). Armstrong et al, (2008) reported that intercropping climbing beans with corn increased CP in the mixture, but also increased neutral detergent fiber concentration and decreased digestibility compared to monoculture corn. Dawo et al, (2007) reported that CP concentration increased 22% in the mixture when corn proportion in the mixture decreased by 50%.

Table 2. Mean squares of tested treatments effect on studied traits

S.O.V	d.f	Phosphorus	Potassium	Nitrogen	Protein
Replication	2	0.0001	0.001	0.006	0.242
Intercropping Culture	8	0.022 **	0.007 **	0.109 **	4.239 **
Error	16	0.0001	0.001	0.003	0.130
CV		5.6%	5.93%	4.49%	4.49%

Note. ** – significant at 1%

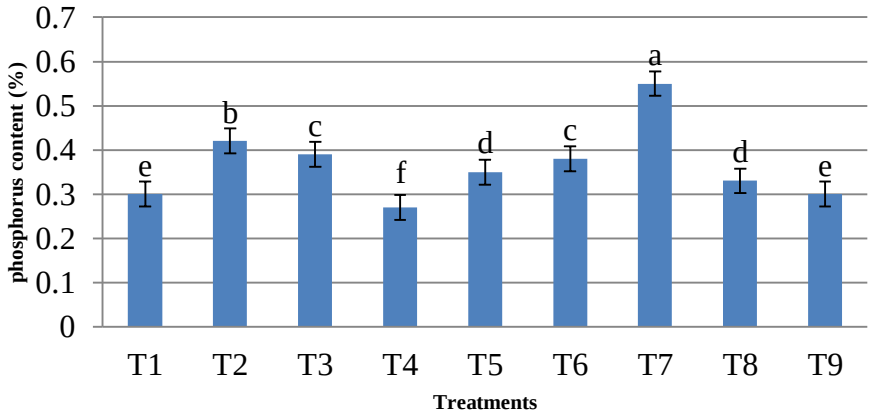

Figure 1. Effect of intercropping system treatments on phosphorus content of corn. Error bars represent the standard deviations of the means of phosphorus content

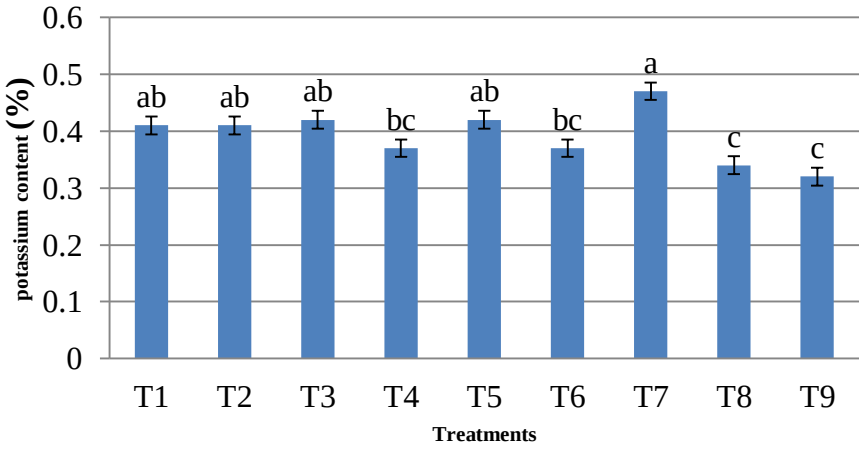

Figure 2. Effect of intercropping system treatments on potassium content of corn. Error bars represent the standard deviations of the means of potassium content

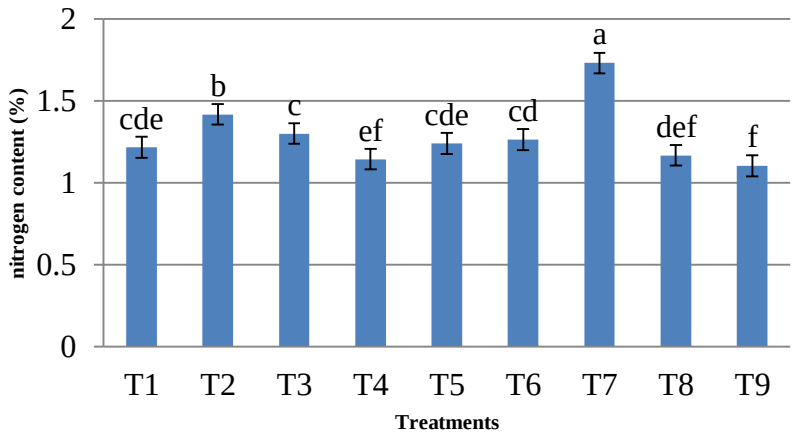

Figure 3. Effect of intercropping system treatments on nitrogen content of corn. Error bars represent the standard deviations of the means of nitrogen content.

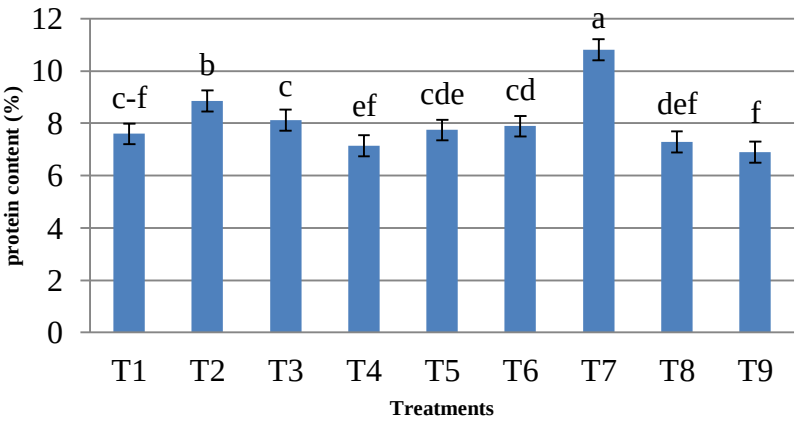

Figure 4. Effect of intercropping system treatments on protein content of corn. Error bars represent the standard deviations of the means of protein content

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