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Evaluation of Maize and Green Bean Yield In Various Densities and Different Sowing Rates of Intercropping by Replacement Method

Arash HOSSEİNPOUR[1]* Javad KHALİLİMAHALLEH[2] Hossein ZEİNALZADEHTABRİZİ[3] Reza VALİLUE[1]

[1] Department of Field Crops, Faculty of Agriculture, Ataturk University, Erzurum, Turkey
[2] Department of Agronomy and Plant Breeding, Khoy branch, Islamic Azad University (IAU), Khoy, Iran
[3] Iranian Academic Center For Education, Culture and Research (ACECR), Hamedan, Iran
(* *Corresponding author*: arash.pour@atauni.edu.tr)

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ABSTRACT : Intercropping of cereals with legumes has been popular in humid tropical environments. In order to evaluation of yield on maize and green bean in various densities and arrangements of intercropping by replacement method, an experiment was conducted as split plot design in completely randomized blocks with three replications in Macoo, Iran in 2009 crop year. The main factor included three density levels (D_1: 60000 plants of maize + 200000 plants of green bean per hectare, D_2: 75000 plants of maize + 300000 plants of green bean per hectare and D_3: 90000 plants of maize + 400000 plants of green bean per hectare, respectively). The sub factor included five planting arrangements (R_1: pure cultivation of green bean, R_2: pure cultivation of maize, R_3: intercropping 50% green bean + 50% maize, R_4: intercropping 75% green bean + 25% maize and R_5: intercropping of 25% green bean + 75% maize, respectively). The results of variance analysis showed maize grain yield was significantly affected by different arrangements of intercropping cultivation and in the green bean was affected by different levels of density. For evaluation of intercropping, Land Equivalent Ratio (LER) and Relative Value Total (RVT) were calculated. The highest amount of LER and RVT were in treatments D_3R_4 and D_3R_5 about 2.17 and treatment D_3R_4 and D_3R_5 about 3.16, respectively. As a conclusion, the mentioned combinations are economically advisable. In relation to competitive indices, the Relative Crowding Coefficient (RCC) and Dominancy were calculated. The highest RCC related to the maize with 1.18 was observed in D_2R_3 treatment. Also, the green bean in D_2R_4 treatment with 1.05 was indicated the highest RCC. The highest dominancy with 2.95 in D_3R_5 treatment was calculated whereas the lowest was D_3R_3 treatment with -3.04. The Relative Crowding Coefficient were associated the maize in most treatments.

Keywords: Density, Green Bean, Intercropping, Maize, Yield

Mısır ve Taze Fasulyenin Birlikte Ekiminde Farklı Ekim Sıklığı ve Oranlarının Verim Bakımından Değerlendirilmesi

ÖZET : Tahıllarla baklagillerin birlikte ekimi nemli tropikal bölgelerde yaygın bir uygulamadır. Bu araştırma mısır ve taze fasulyenin birlikte ekiminde farklı ekim sıklığı ve ekim desenlerinin verim üzerine etkisinin belirnenmesi amacıyla bölünmüş parseller düzenine göre tesadüf blokları deneme deseninde üç tekerrürlü olarak 2009 ürün yılında Iran'ın Makü şehrinde yürütülmüştür. Ana faktör üç faklı ekim sıklığı seviyesinden (D_1: 60000 mısır + 200000 fasulye/ha, D_2: 75000 mısır + 300000 fasulye/ ha ve D_3: 90000 mısır + 400000 fasulye/ha) oluşmaktadır. Alt faktör ise beş ekim düzenlemesinden (R_1: %100 fasulye , R_2: %100 mısır , R_3: %50 fasulye + %50 mısır, R_4: %75 fasulye + %25 mısır ve R_5: %25 fasulye + %75 mısır) oluşmaktadır. Varyans analiz sonuçlarına göre mısır verimi farklı ekim desenlerinden, fasulye verimi ise ekim sıklığından önemli ölçüde etkilenmiştir. Birlikte ekimin etkinliğini değerlendirmek amacıyla alan eşdeğer oranı (LER) ve toplam nispi değer (RTV) hesaplanmıştır. En yüksek LER ve RTV sırasıyla yaklaşık 2.17 ve 3.16 D_3R_4 ve D_3R_5 uygulamalarında belirlenmiş ve bu kombinasyonlar ümitvar bulunmuştur. Rekabet indeksleri bakımından, göreceli sıklık katsayısı (RCC) ve rekabet değerleri hesaplanmıştır. En yüksek RCC mısır için D_2R_3 (1.18), fasulye için D_2R_4 (1.05) uygulamalarında belirlenmiştir. En yüksek rekabet değeri D_3R_5 (2.95), ve en az D_3R_3 (-3.04) uygulamalarında saptanmıştır.

Anahtar kelimeler: Birlikte ekim, ekim sıklığı, mısır, taze fasulye ve verim

INTRODUCTION

Intercropping system, by increasing the number of species per unit area, is recommended as a way to increase the production in advanced agriculture (Brummer, 1998). Intercropping as a method of sustainable agriculture is the simultaneous growing of two or more crops during the same season on the same area, which utilize common limiting resources better than the species grown separately as an efficient resource use method (Ghosh *et al.,* 2006; Sobkowicz, 2006). Intercropping of cereals with legumes has been popular in humid tropical environments (Tsubo *et al.,* 2005). The main advantage of intercropping is increasing production per unit area compare to a single cultivation due to the better use of environmental factors such as light, water and nutrients in the soil. In fact, in intercropping, the optimal use of environmental resources such as water, light soil and nutrients has been attributed to the height difference, how to place aerial and underground organ and different plant's food need (Hashemi-Dezfoli *et al.,* 2001). Most common word used in the intercropping is multi cultivation that is divided into two sub categories consecutive culture and intercropping (Sullivan 2003). Multi cultivation is planting two or more plants in a piece of land and in a crop year, but in intercropping, both space and time is raised and competition in all or part of growing stages of the plants are established (Talekar *et al.,* 1986). Intercropping is the growing of one or more crops simultaneously in a piece of land during crop season (Sullivan, 2003). Intercropping is done in the form of increasing and replacement systems so that in increasing system, by removing one of the species in multi cultivation a single cultivation can be easily created but in a replacement cultivation system, considering all the circumstances of a species in intercropping, a similar species can be replaced and create the single cultivation (Javanshir *et al.,* 2000). Advantages of intercropping system are soil conservation and erosion control, efficient use of water and resources, product stability and stability of yield, maintaining more plant residue in soil, protection from wind and cold damages, physical protection and increase crop’s quality in intercropping, high economic efficiency and increase nitrogen fixation by legumes in intercropping system. The main advantage of legume intercropping is complementary use of nitrogen (Mazaheri *et al.,* 2002). The superior of yield stability in intercropping in comparison to pure cultivation is attributed to the ability of mixed components in completing each other and overall, their efficiency in using more resources. Such interaction effect can be called complete yield of cultivation (Remison and Lucas, 1982). Intercropping of cereal legume is the most common methods of intercropping. Maize is one of the most important food and strategic crops and bean is rich in protein, so they can produce a complete starch and protein food per unit area according to their physiological and morphological characteristics. These plants can be complementary in the use of environmental resources regarding maize stem. It has fibrous and shallow root but bean has deep and direct one. Therefore, this difference in root system can make the most use from the food in soil and its moisture, and on the other hand bean has the ability for fixation and using atmospheric nitrogen so the amount of nitrogen in soil can be used and competition for nitrogen nutrient, which is one of the most important nutrient element for plants is reduced. Also *leguminosae* family plants according to their lying and creeping habit, provide appropriate cover at the soil surface and reduce soil erosion, smother weeds and prevent water evaporation from the soil surface (Baqeri and Parsa, 2008). Cheng and Lur (2008) suggested that Ethylene possibly could have been involved in the development of percent abortion in maize. Johnson (2000) stated that one of the causes of incomplete kernel set is unsuccessful pollination. Unsuccessful pollination results in ovules that are never fertilized and, subsequently, ears with varying degrees and patterns of incomplete kernel set. According to Pirzad (2000), in order to maintain yield in intercropping system, density should be more than desirable pure cultivation. Akunda (2004) reported that using legumes in intercropping and in biological nitrogen fixing, nitrogen fertilizer consumption is reduced and its effect is preventing the environmental pollution.

The objectives of this research are to investigate of the planting density of maize and green beans, assessment of the excellent yield of intercropping system compared to pure cultivation and determine the best arrangement and plant density.

MATERIAL AND METHODS

This field experiment was carried out with latitude of 39°, 20' and longitude of 44°, 23’ at an altitude of 1411 m above mean sea level in 2009 crop year in Macco city, Iran. This area has a mean annual temperature of 11.6^{o}C. Rainfall of crop year 2009-2010 was 400.4 ml. During the growing season the mean minimum, maximum and average daily temperature were 11.60, 22.08 and 16.84^{o}C, respectively. Total rainfall during the experiment was 47.65 mm and the total evaporation was 173.05 ml. Maximum rainfall occurred in June. Maize (*Zea maize* var, 704, with 120 - 150 days growing period and 240 – 300 cm plant height) and green bean (*Green veladat* var 532, with 85 - 100 days growing period and 50 – 60 cm plant height) were used in the experiment.

The experiment was carried out as split plot in completely randomized blocks with three replications. The main factor included three density levels (D_1: 60000 plants of maize + 200000 plants of green bean per hectare, D_2: 75000 plants of maize + 300000 plants of green bean per hectare and D_3: 90000 plants of maize + 400000 plants of green bean per hectare, respectively). The sub factor included five planting arrangements (R_1: pure cultivation of green bean, R_2: pure cultivation of maize, R_3: intercropping 50% green bean + 50% maize, R_4: intercropping 75% green bean + 25% maize and R_5: intercropping of 25% green bean + 75% maize, respectively). Seed bed preparation included ploughing, disk harrowing and cultivation. Sowings were performed manually by planting twice more seeds than the expected plant densities and then rows were thinned to the required densities. For mono and intercropped maize treatments, a basal application of nitrogen and phosphorous were carried out at sowing time, using urea and P_2O_5 fertilizers at the rate of 60 kg/ha and 100 kg/ha, respectively. About 60 kg/ha urea was also added to the soil when maize plants were 40-50 cm height. The experiment was carried out on the basis of the design map on May 15. 2009.

The remaining urea 60 kg/ha was added to the soil when maize was in anthesis – silking interval.

The sole-cropped green bean received 50 kg/ha of P_2O_5 during planting. The center of stack in this experiment line spacing for maize and bean was 60 cm for both of them the densities were adjusted by changing the distances on the cultivated lines each experimental unit was of five length and 3.6 m width and the experimental included 45 experimental units. Plots were irrigated as at when needed. Weed control was performed manually. Maize was harvested at complete maturity a green bean plants were harvested when the most pods fully immature and plump but before seeds harden or pods yellow.

Predicted yield (prediction yield is equal to the multiplying proportion of product *a* in intercropping in the yield of the pure culture the product) and real yield obtained in practice is examined.

In order to evaluate the competitive effects among component crops and to determine intercropping yield in mixture and sole crop Land Equivalent Ratio and Relative Value Total were calculated (Mazaheri *et al.,* 2002) as

$$LER = \frac{Y_{ab}}{Y_{aa}} + \frac{Y_{ba}}{Y_{bb}} \quad (1)$$

Where, Y_{ab} and Y_{ba} are the yields of two different crops in intercropping and Y_{aa}, Y_{bb} are the yields of these crops in monocultures. Formula is used If LER is greater than one, intercropping will be better than pure cultivation (Mazaheri *et al.* 2002) and if LER is less than one, pure cultivation will be better (Hauggaard-Nielsen *et al.* 2001).

Any result would signify an intercropping advantage; any result below one signifies a monoculture advantage. The problem with LER is that such calculation does not account for the value of the crops that are being sown (Moseley, 1994).

The solution to this problem is provided in calculating Relative Value Total (RVT) of the crop mixtures. Such calculation is relevant for the farmer that has monetary value as his farming goal (Vandermeer, 1992). RVT is given as

$$RVT = \frac{(ap_1 + bp_2)}{am_1} \quad (2)$$

Where a, b are price yields of two different crops and p_1, p_2 and m_1 the yields of two different crops in intercropping crop 1 and 2 respectively.

By using dominance, the extra product of plant to other one is determined. If sample *a* is intercropping by sample *b* by replacement method.

Relative Crowding Coefficient can be summarized as follow:

$$RCC_{ab} = (Yab / Yaa) / (Yba / Ybb) \quad (3)$$

$$RCC_{ba} = (Yba / Ybb) / (Yab / Yaa)$$

Dominance is given as:

$$A_{ab} = (Yab / Yaa) - (Yba / Ybb) \quad (4)$$

$$B_{ab} = (Yba / Ybb) - (Yab / Yaa)$$

Where, Y_{ab} and Y_{ba} are the yields of two different crops in intercropping and Y_{aa}, Y_{bb} are the yields of those of these crops in monocultures. If the dominant coefficient is zero, it means the inside and outside species competition is the same and there is no competition between two species. If the dominance coefficient is greater than zero, then the competitive power of species a is more than b in intercropping and if the dominance competition is less than zero, then the competitive power of species b is more in intercropping (Dabagh-Mohammadi-Nasab, 2003; Zhang and Li, 2003).

The obtained data were variance analyzed by statistical software SAS (SAS Institute, 2002) and the means were compared with a Least Significant Difference (LSD) test and EXCEL software for sketching curves and graphs.

Results and discussion

In the present study, analysis of variance (Table 1) indicated that there were significant ($P \leq 0.01$) differences among different density based on plant height, ear distance from the ground, but it had significant effects on percent seed abortion in maize ($P \leq 0.05$) (Table 1).

Table 1. Analysis of variance for plant height, ear distance from the ground, percent abortion maize and grain yields of maize.

		MS			
Sources of variations	d.f	Plant height	Ear distance from the ground	Percent abortion maize	Grain yield
Density (A)	2	601.74**	618.48**	28.06*	6839962.30
Error	4	38.16	24.47	3.73	1840815.51
Planting ratio (B)	3	547.88**	373.25**	13.37**	3228339.13**
A×B	6	14.89	11.02	2.33	539337.25
Error	1	20.12	19.86	3.08	604481.35
CV (%)		1.56	4.14	12.61	9.30

*, **: Significant at $p \leq 0.05$ and $p \leq 0.01$, respectively.

The comparison of mean treatment of different levels of density showed that the highest and lowest plant height, ear distance from the ground and percent seed abortion in maize were in treatment D_3 respectively with an average of 294.7 cm, 104.9 cm and 18.27 cm and treatment D_1 was with an average of 280.66 cm, 99.11 cm and 13.69 cm (Table 2).

Table 2. Mean comparison of plant height, ear distance from the ground, percent seed abortion in maize and grain yield of maize.

Treatment	Plant height (cm)	Ear distance from the ground (cm)	Percent seed abortion in maize (%)	Grain yield (kg/ha)
Density				
D_1	280.60 ^{c}	99.11 ^{b}	13.69 ^{c}	8016.00
D_2	286.00 ^{b}	102.10 ^{ab}	16.46 ^{b}	8505.00
D_3	294.70 ^{a}	104.90 ^{a}	18.27 ^{a}	8565.00
LSD %5	5.27		2.06	913.60
Planting ratio				
R_1	296.10 ^{a}	113.60 ^{a}	21.29 ^{a}	7880.00 ^{b}
R_2	289.60 ^{b}	105.80 ^{b}	17.46 ^{b}	9157.00 ^{a}
R_3	285.30 ^{b}	102.30 ^{b}	14.85 ^{c}	8491.00 ^{ab}
R_4	277.50 ^{c}	86.46 ^{c}	10.96 ^{d}	7920.00 ^{b}
LSD%5	6.08		2.38	1055.00

Means within the same column and rows and factors, followed by the same letter are not significantly difference (P<0.05).

D_1 (60000 plants of maize + 200000 plants of green bean per hectare), D_2 (75000 plants of maize + 300000 plants of green bean per hectare), D_3 (90000 plants of maize + 400000 plants of green bean per hectare), R_1: pure cultivation of maize, R_2: intercropping %75 maize + %25 green bean, R_3: intercropping of %50 maize + %50 green bean, R_4: intercropping of %25 maize + %75 green bean.

The plant increasing with increasing density can be attributed to the lack of light oxidation of auxin (Atri, 1999). Remison and Lucas (1982) in their studies based on density effect on height of ear in two varieties of maize concluded that with increasing maize density, the height of ear is increased from ground. Surface stem height increasing and consequently increasing the distance of ear from the ground level was reported by Harris *et al.* (1999). In most cases of the high seed abortion percent of the ear with increasing plant density, it seems that the reason for this can be attributed to the competition within a species, which reduces nutritional status of the crop and lead to reduction in the percentage of seed abortion in ear per plant. Singh *et al.* (1986) reported that in the intercropping of maize and bean in replacement method, maize and bean crop yield is increased per unit area in intercropping system. Sullivan (2003) indicated that to have a good chance of desirable yield in intercropping, it’s necessary to reduce the seed amount of each of its components. Using bean in intercropping increased the efficiency use of water, light and nutrients and entered the nitrogen to soil through biological fixation (Zhang and Li, 2003). Tetio-Kagho and Gardner (1988) in assessment of maize and bean intercropping concluded that by increasing maize planting to three times, could results %24 reduction in leaf area and %70 of grain yield in planting bean. Tayefehnuri (2004) expressed that by incremental intercropping of maize and bean, the usefulness of intercropping system to pure increased.

Analysis of variance (Table 1) showed that there were significant ($P \leq 0.01$) differences among planting rate based on plant height, ear distance from the ground, percentage seed abortion in maize and grain yield. Comparison of mean treatment of planting rate showed the maximum plant height, the distance of ear from ground surface and the percentage seed abortion in maize were in R_1 treatment, respectively with an average of 296.1 cm, 113.6 cm and 21.29 cm and the least amount of them was in R_4 treatment, respectively, with an average of 277.15 cm, 86.46 cm and 10.96 cm. The highest grain yield was placed in R_2 treatment with an average 9157.00 kg per hectare and the lowest grain yield was related to R_1 treatment with an average of 7880.00 gr per hectare (Table 2). About plant height and ear distance from ground, it can be said that in intercropping treatment, there was not any inter species competition and the space for better growing of maize was provided. Yunusa (1989) showed that maize height and distance of ear from ground in pure cultivation was more than intercropping system of maize and soybean. Regarding to less seed percentage abortion in treatment R_4 it can be refer to the biological fixation of more nitrogen and increasing nutrition space of plant and reducing the inside species competition. Motallebizadeh (2006) reported that the grain yield in intercropping system was 75% maize + 25% bean, which is the same as the results. It seems the cause of seed yield in the mentioned treatment can be due to most relationship between species and nitrogen fixation by the stem of green bean and provide it to maize. Najafi and Mohammadi (2005) in studying of yield and its yield components in intercropping system of sweet maize and green bean concluded that the yield of all the intercropping system is higher than pure cultivation. Abraham and Singh (1984) and Premalal *et al.* (1993) also found similar results in their research.

The results of variance analysis showed that the plant density had highly significant effect ($P \leq 0.01$) on plant height, distance of pod from the ground, number of pod per m^2, but green bean yield had significant effect ($P \leq 0.05$) (Table 3).

Table 3. Analysis of variance for plant height, distance of pod from the ground, number of pod per m^2 and green bean yield of green bean.

		MS			
Sources of variations	d.f	Plant height	Distance of pod from the ground	Number of pod per m^2	Green bean yield
Density (A)	2	18.91**	8.38**	71478.08**	71255825.33*
Error	4	0.70	0.31	1549.91	6055256.16
Planting (B)	3	5.18**	1.40**	1058.69	1630575.74
A×B	6	0.44	0.08	336.08	1522828.29
Error	1	0.73	0.02	1759.57	712761.75
CV (%)		2.43	4.33	11.12	5.37

*, **: Significant at $p \leq 0.05$ and $p \leq 0.01$, respectively.

Plant height, distance of pod from the ground, number of pod per m^2, and green bean yield were the highest in D_3 (36.55 cm, 12.35 cm, 450.45 numbers and 17615 kg per hectare, respectively) and were the lowest in D_1 (34.04 cm, 11.01 cm, 296.7 numbers and 13708.00 kg per hectare, respectively) (Table 4).

Table 4. Mean comparison of plant height, distance of pod from the ground, Number of pod per m^2 and grain yield of bean.

Treatment	Plant height (cm)	Distance of pod from the ground (cm)	Number of per m^2	Green bean yield (kg/ha)
Density				
D_1	34.04 c	11.01 b	296.70 c	13708.00 c
D_2	35.17 b	12.07 a	384.60 b	15845.00 b
D_3	36.55 a	12.35 a	450.45 a	17615.00 a
LSD %5	1.00	0.60	49.29	724.10
Planting ratio				
R_1	34.46 b	11.04 b	363.70	15470.00
R_2	34.86 b	11.91 ab	375.40	15420.00
R_3	35.49 ab	11.92 ab	389.80	16330.00
R_4	36.19 a	12.37 a	380.10	15670.00
LSD%5	1.16	0.69	56.92	836.10

Means within the same column and rows and factors, followed by the same letter are not significantly difference (P<0.05).

D1 (60000 plants of maize + 200000 plants of green bean per hectare), D2 (75000 plants of maize + 300000 plants of green bean per hectare), D3 (90000 plants of maize + 400000 plants of green bean per hectare), R1: pure cultivation of green bean, R2: intercropping %75 green bean + %25 maize, R3: intercropping of %50 green bean + %50 maize, R4: intercropping of %25 green bean + %75 maize.

The results show by increasing green bean density, the plants increase their height for obtaining the needed light. Latifiyan (2010) also have reported similar results with increasing the density of green bean, the distance of first pod from ground surface in green bean plant is increased. Mazaheri *et al.* (2002) pointed out that with increasing in density, the pod number per unit area in plant is reduced. Jadoski *et al.* (2000) in an experiment on different densities of bean declared that with reducing density, the competition for light and nutrients is reduced and number of pod in plant are increased. Tayefehnuri (2004) and Pourtaghi (2004) declared with increasing the density of bean the seed yield per area is increased and the maximum seed yield per unit area was obtained in high densities of bean. (Jadoski *et al.,* 2000) reported with decreasing density, the competition within the species decreased and bean seed yield increased per unit area of cultivation.

Effect of different arrangements of intercropping on plant height and the distance of pod from the ground was significant ($p<0.01$), but interaction effect was insignificant in all studied traits (Table 4). Comparison of planting rate of treatments showed the highest and lowest plant height and the distance of pod from the ground respectively in R_4 treatment are with an average of 36.19 cm and 12.37 cm in *a* statistical group and the least was in R_1 treatment with an average of 34.46 cm and 11.04 cm, which *b* and *ab* did not have significant difference with other treatments (Table 4).

The cause of high height of green bean plant in the mentioned treatment can be because of shading by maize in intercropping system with green bean which will increase the height. Pourtaghi (2004) and Carruthers *et al.* (2000) by intercropping system of maize and bean declared that the number of seed per bean pod was not affected. Bindra and Thakur (2005) and Dua *et al.* (2005) by intercropping system of potato and green bean, stated that number of seed per bean pod was not affected. Number of pod per m^2 decreasing per green bean plant is because of increasing maize density due to significant shading of maize on green bean and reduction of photosynthetic substances in green bean and is due to reducing of green bean growth. Rahimi *et al.* (2002) in assessment of crop in intercropping system of maize and soybean showed that different arrangement in maize seeds weight does not have significant effect. Barzegari *et al.* (2005) reported in a research to study various combinations of intercropping system of maize and bean that in intercropping system the amount of seed yield is increased per unit area.

1. Evaluation indicators of intercropping

A: Land Equivalent Ratio

In this study, the Land Equivalent Ratio (LER) in all treatments was more than one (Table 5). This can be a useful indicator of maize and green bean intercropping. In order to morphological differences between two species and therefore creation of different stages and utilization of resources, treatments D_3R_4 and D_3R_5 gave the maximum amount of LER about 2.17. Based on experiments performed by Katang (1989) the maximum value of LER in intercropping of beans and sweet maize was 1.32. He concluded that bean is the best plant species for intercropping with maize. Pourtaghi (2004) and Dabagh-Mohammadi-Nasab (2003) announced in intercropping of maize and pinto bean and intercropping of sorghum and soybean, the highest value of LER is achieved at the highest density of both plants.

B: Relative Value Total

Another indicator used in assessment of intercropping is Relative Value Total (RVT), which evaluate intercropping in terms of economic value. By placing the numbers associated with each parameter in the formula of this index, the economic value of each treatments of intercropping can be calculated and interpreted. In calculations of this research, the daily price tested products was used, so that the price of each kilogram of maize seed was calculated about 0.9 dollar and green bean, about 1.8 dollar. Treatments D_3R_4 and D_3R_5 showed the highest value of RVT about 3.16. Tayefehnuri (2004) reported that the value of RVT is more than one and the highest value (1.34) was obtained in high density of maize and pinto bean intercropping.

2. Evaluation indicators of competitiveness

A: Relative Crowding Coefficient

Relative Crowding Coefficient (RCC) is ability of a species to use limited resource in intercropping with its ability to gain the same resource in intercropping system by using yield comparing and shows the competitive advantage of intercropping components (Snaydon 1991). RCC of maize was generally higher than that of bean. The highest value of RCC was observed in D_2R_3 for maize and in D_2R_4 for bean (Table 5). Pirzad (2000) reported that maize is competitively superior to soybean in maize and soybean intercropping

B: Dominance

Dominance is an index that shows the relative yield difference between two species and generally shows the intensity of competition quantitative. By using this method, the extra value of each crop to another can be determined (Dabagh-Mohammadi-

Nasab 2003). Actual yield of maize in the most treatments of intercropping system compare to Predicted yield of maize was higher than actual yield of been in intercropping to predicted yield of been. The highest value was in treatment D_3R_5 with an average of 2.95 and the lowest was D_3R_3 treatment with an average of -3.04 (Table 5). Tayefehnuri (2004) and Pourtaghi (2004) by planting intercropping of maize and bean announced that maize was dominance rather than been.

Table 5. Land equivalent ratio (LER), relative value of total (RVT), Relative Crowding Coefficient and Dominance for grain yields of maize and green bean at different density and planting ratio in intercropping system.

Density	Planting ratio	LER	RVT	RCC		Dominant
				Maize	Green bean	
D_1	R_3	1.71	2.73	1.36	0.73	-1.94
D_1	R_4	1.73	2.84	1.09	0.92	0.18
D_1	R_5	1.54	2.56	1.01	0.99	2.53
D_2	R_3	2.13	2.86	1.18	0.85	-2.4
D_2	R_4	2.00	2.75	0.96	1.05	-0.09
D_2	R_5	1.98	2.56	0.98	1.02	2.6
D_3	R_3	2.06	2.99	1.07	0.97	-3.04
D_3	R_4	2.17	3.16	1.01	0.99	0.01
D_3	R_5	2.17	3.16	1.03	1.01	2.91

CONCLUSION

Based on the results of the experiment, treatment D_3R_4 and D_3R_5 respectively produced the highest grain yield of maize and green been per unit area, respectively. Evaluation of different treatments of intercropping by LER and RVT showed that in all the treatments the value of LER and RVT was more than one.

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