Journal of Agricultural Science; Vol. 9, No. 5; 2017
ISSN 1916-9752 E-ISSN 1916-9760
Published by Canadian Center of Science and Education

Effect of Vermicompost on Yield and Forage Quality in Intercropping of Maize and Mung

Parastoo Shadab Niazi[1], Reza Monaem[1] & Amin Azadi[1]

[1] Department of Agriculture, University of Shahre Rey, Tehran, Iran

Correspondence: Parastoo Shadab Niazi, Department of Agriculture, University of Shahre Rey, Tehran, Iran. Tel: 0098-912-425-3957. Email: parastoo.shadab90@gmail.com

Received: March 1, 2017 Accepted: April 1, 2017 Online Published: April 15, 2017

doi:10.5539/jas.v9n5p233 URL: https://doi.org/10.5539/jas.v9n5p233

Abstract

To evaluate the quality and quantity of forage maize and green mung beans in monoculture and mixed farming an experiment was carried out in the form of split plot in a randomized complete block design with three replications at educational and research center of Azad University of Shahre Rey in 2013. Vermicompost was considered at three levels in the main plots (zero, 2.5 and 5 tons per ha) and mixed planting of five levels as subplots (100% green gram; 100% corn; 50% green gram and 50% corn; 75% and 25% of corn plus 25% and 75% of mung bean respectively). The results showed that the highest forage dry yield belonged to 75% maize + 25% mung bean. Forage quality of intercropping of maize and mung bean was higher than maize monoculture. The highest digestibility belonged to 75% mung bean + 25% corn, which statistically had no significant difference compared with 50% corn + 50% mung bean.

Keywords: vermicompost, maize, mung bean, intercropping

1. Introduction

The current problems of humanity could be environmental degradation, low yield per unit area, and population growth (Timothy et al., 2000). One of the most important contributing factors to the physical and chemical degradation of agricultural soil in developing countries is uncontrolled use of chemical fertilizers in cultivation of monoculture crops. In such situations, the application of the principles of sustainable agriculture is to meet the current needs of communities and preventing compromising the resources of future generations (Rahimi et al., 2002). Key strategies in sustainable agriculture are to restore diversification of agricultural ecosystems and its effective management. Intercropping, as an example of a sustainable system in agriculture, pursues the goal of ecological balance; further exploitation of resources; increasing the quality and quantity of yield, and reducing pests, diseases and weeds; decreasing farmers' dependence on pesticides; as well as preserving product quality and marketability (Fenandez-Aparicio, 2007; Ghosh, 2004; Lithourgidis, 2007).

On the other hand, many studies have shown that vermicompost is a stable and effective combination for soil pH, which makes the soil nutrients and fertilizers available (Maboeta & Rensburg, 2003; Mkhabelaa & Warman, 2005).

Results of Jonathan (2008) in intercropping cowpea and maize showed not only an increase in performance, stability, and soil nutrients, and a decline in pests and diseases, but also effective use of the workforce, reduced risk, increased species diversity, and increased productivity in intercropping, which were all higher than monoculture. Also, Strydhorst et al.'s (2008) review of barley intercropping with faba bean, lupine and peas stated that forage dry matter yield, nutritional value and economic returns were achieved in the cultivation of peas mixed with barley. Similar results by Lameii Hervani (2013) showed that intercropping ratio of 75% barley with 25 percent of vetch in terms of dry matter production was the most suitable cultivation.

The results from Bachman and Metzger (2008) suggested that the combination of 10 and 20 wt% vermicompost improves the conditions of potted potato seedlings and marigold.

2. Materials and Methods

The experiment was conducted in Rey, a city with the latitude of 35 degrees 42 minutes and longitude of 51 degrees 25 minutes and 1060 meters above sea level. In order to determine soil characteristics, soil sampling was performed before the experiment. To do this, field soil sampling was done from the depth of 30-0 cm in several spots. Then the collected samples were mixed and sent to the laboratory in order to determine soil texture and the chemical composition.

Table 1. Field soil profile

Sampling Depth (cm)	Ph	EC (ds/m)	OC (%)	N (%)	P (%)	K (ppm)	Clay (%)	Silt (%)	Sand (%)	Texture
0-30	7.8	3.45	0.33	0.1	14	447.8	22	42	38	Loam-clay

Table 2. Vermicompost specifications

Profile	Zn (ppm)	Mn (ppm)	Fe (ppm)	Cu (ppm)	OC (%)	OM (%)	C/N	Ec (ds/m)	PH	N (%)	K_2O (%)	P_2O_5 (%)
Test method	Atomic	Atomic	Atomic	Atomic	Walkley black	Nitration	-	Conductometer	pH meter	Kjeldahl	Film photometry	Olsen
Vermicompost	29.54	26.31	38.76	5.61	8.12	62	14.43	1.1	7.1	5.21	3.12	14.89

As preparation, the ground was deeply plowed in fall and to crush clods, perpendicular disks were applied twice in early March. Each plot consists of 8 rows with a distance of 50 cm and a length of 3 meters, 2 meters' distance between the main plots, and 1 m between subplots. Since implementing sustainable agriculture was the aim, no chemical fertilizer was applied, but during the growing season irrigation, hand weeding and thinning was carried out according to the local procedure. Planting operations for both plants were done simultaneously in the form of wet work and cluster patterns after mixing vermicompost with soil at the beginning of May. Intercropping treatments were planted in alternative methods. Planting ratios were done by changing the density (changing distance between two rows) and fixed distance between two rows (50 cm). To measure the height of plants, 10 plants were randomly selected and measured. Forage dry matter yield for each treatment sampled from two square meters in dough stage was harvested and weighed from the two central rows, by removing the marginal effects. The samples were then transported to the laboratory and put in an oven at 74 °C for 72 hours to dry. To determine the qualitative characteristics of the forage, samples of both plants were chopped to 1.0 mm using a grinder and prepared based on their mixing ratios, *i.e.* for 50% corn + 50% mung bean ratio a 100-gram sample would contain 50 grams of corn and 50 grams of mung bean.

Total protein extraction was performed by Bradford's (1976) method. That means 5.0 grams of corn and mung bean fresh tissue were placed in a cold mortar (ice bath) and then extraction buffer, containing hydrochloric acid 0.5% + Na2EDTANa2 a 2.0 molar and mercaptoethanol 0.04 percent, and distilled water were added to the sample. Next, the sample was ground for 10 minutes. The raito of extraction buffer in plant samples was 5 ml to 5.0 grams. Extracts were mixed by a 20,000-rpm centrifuge at 4 °C for 20 min. The clear supernatant solution was then used to measure the total protein. The solution was frozen at -70 °C prior to the experiment. 5 ml of Bradford reagent was added to 100 ml of extraction solution and the solution turned blue. After 25 minutes, the absorption of each tube was measured at a wavelength of 595 nm in the presence of a witness. 100 mg of Blue Kumasi was dissolved in 50 mL of 96% ethanol and 100 ml of 85% phosphoric acid was gradually added. The obtained solution reached a volume of 1000 ml with distilled water. Then, having been refrigerated overnight, the solution was sifted with Whatman paper No. 1 and poured in a dark glass and kept in the refrigerator.

The following formulas were used in order to measure LER for each product and for the entire intercropping (Mead & Willey, 1980),

$$LER\ (T) = LER\ (c) + LER\ (m) \tag{1}$$

$$LER\ (c) = Y\ (cm)/Y\ (cc) \tag{2}$$

$$LER\ (m) = Y\ (mc)/Y\ (mm) \tag{3}$$

Where, LER (T) is the whole equality ratio, LER (c) the corn equality ratio, LER (m) the mung bean quality ratio, Y (cm) and Y (mc) mung bean and corn yield in intercropping, and Y (cc) and Y (mm) corn and mung bean monoculture respectively. Finally, data were analyzed by SAS software. Mean comparisons were conducted by Duncan test at 0.05 probability level and diagrams were drawn by Excel software.

3. Results

3.1 Corn Plant Height

Results of analysis of variance table (Table 3) showed that application of different levels of vermicompost and different mixing ratios has a significant influence on corn height. Table of traits mean comparison also suggested that there are significant differences between the traits averages (Table 4), in that the maximum height of maize with 139.9 cm was obtained by application of 5 tons per hectare of vermicompost. In addition, as for mixing ratios, the highest corn height with 132.4 cm was obtained from the ratio of 75% mung bean and 25% corn and the lowest of 111.28 cm in height from monoculture of maize.

Table 3. Analysis of variance (mean square) yield and quality of corn and mung bean intercropping

S.O.V	df	Maize height	Maize dry forage yield	Mung bean dry forage yield	Maize protein	Mung bean protein
Rep	2	1395.53^{ns}	160321.3^{ns}	5498.06^{ns}	0.23^{ns}	42.53^{ns}
Vermicompost levels	2	1821.11*	1481214.7**	2366.4*	7.44**	9.41^{ns}
Main error	4	0.011	43561.021	6554.12	0.43	1.08
Mixing ratio	4	525.01**	344779034.9**	21335708.3**	7.9**	57.9**
Mixing ratio* Vermicompost levels	6	0.173*	56204657.53*	3011.81*	25.21*	72.07*
Sub error	18	0.013	77231.5	4228.07	0.41	21.6
CV	-	15	16.3	18.9	5.5	8.8

Note. *, ** and ^{ns} significant in 5 and 1 probability level and nonsignificant respectively.

Table 4. Compares the average of the yield and quality of corn and mung bean intercropping

	Maize height (cm)	Maize dry forage yield (kg/ha)	Mung dry forage yield (kg/ha)	Maize protein (%)	Mung protein (%)
Vermicompost levels					
V_1	111.28 ^{c}	15122.4 ^{c}	1441.2 ^{c}	9.18 ^{c}	22.3944 ^{a}
V_2	129.12 ^{b}	16401.1 ^{b}	1500.6 ^{b}	11.21 ^{b}	22.4011 ^{a}
V_3	139.9 ^{a}	17007.6 ^{a}	1602.5 ^{a}	12.89 ^{a}	22.6544 ^{a}
Mixing ratio					
100% maize	132.4 ^{d}	13001.3 ^{d}	-	10.4 ^{d}	-
100% mung bean	-	-	2444.9 ^{a}	-	20.08 ^{a}
50% maize-50% mung bean	136.3 ^{c}	14034.4 ^{c}	1011 ^{c}	16.3 ^{a}	17.5 ^{c}
25% maize-75% mung bean	139.6 ^{a}	17009.1 ^{a}	1633.7 ^{b}	15.1 ^{b}	19 ^{b}
75% maize-25% mung bean	138 ^{b}	15102 ^{b}	950.5 ^{d}	14.9 ^{c}	15.35 ^{d}

Note. Same letters in each column represent no significant differences in the level of 5 percent.

3.2 Dry Matter Yield of Corn and Mung

The results showed that different levels of vermicompost had very significant effects on dry plant weight of corn and green gram (Table 3). The highest corn dry matter yield, 17007 kg per hectare, was obtained by the application of 5 tons per hectare vermicompost. The lowest corn dry matter yield with 15122 kg per hectare was recorded for the non-application of vermicompost (Table 4). Also the highest yield of mung fresh matter with 4091 kg per hectare belonged to the application of 5 tons per hectare of vermicompost. The fresh yield with the lowest 3006 kg per hectare was the one regarding the use of non-application of vermicompost.

3.3 Protein Percentage of Maize and Mung Forage

Analysis of variance table (Table 3) showed that different levels of vermicompost had very significant effects on forage maize and mung bean protein. Means comparisons table also revealed a significant difference between the percentage of corn and mung bean forage protein under the influence of different levels of vermicompost (Table 4). The highest protein percentage of forage maize, by 12.89%, refered to that of 5 tons per hectare usage of vermicompost and the lowest, being 9.18 percent, was related to non-application of vermicompost. As for percentages of mung bean proteins, the highest and lowest levels, 20.65% and 10.39% respectively, belonged to the same amounts of vermicompost used. Among the different intercropping ratios, the highest protein content of maize, 18.2 percent, was related to the application of 5 tph of vermicompost and 50% corn, 50% mung bean. Also the lowest protein content of corn, 12.5 percent, was related to the non-application of vermicompost with the corn ratio of 100%. Mung's highest and lowest protein levels were 20.08 and 15.35 percent respectively with the ratios of 100 percent and 25 percent of mung and 75 percent corn.

3.4 Land Equivalent Ratio (LER)

Evaluation of intercropping is usually expressed by land equivalent ratio; increased land equivalent ratio represents the relative efficiency of intercropping to monocultures of each of the plants used in intercropping. Analysis of variance (Table 5) showed that the LER had significant differences under the influence of different levels of vermicompost, different ratios in intercropping and interactions of vermicompost in different ratios of intercropping. Means comparison also showed that among different levels of vermicompost, the use of 5 tons per hectare and among different ratios of intercropping, the sowing of 25 percent mung and 75 percent corn had the highest LER (Table 6).

Table 5. Analysis of variance (mean square) LER of application of vermicompost in intercropping of maize and mung

SOV	df	Maize	Mung bean	Total
block	2	0.000053^{ns}	0.000083^{ns}	0.0002^{ns}
Vermicompost level	2	0.00091^{**}	0.00017^{ns}	0.00085^{**}
Main error	4	0.000088	0.00014	0.000044
Mixing ratio	2	2.33^{**}	0.3311^{**}	0.717^{**}
Mixing ratio* Vermicompost level	4	0.00031^{**}	0.000055^{ns}	0.00034^{**}
Sub error	12	0.000022	0.000061	0.000054
CV	-	0.65	2.91	0.89

Note. *, ** and ^{ns} significant in 5 and 1 probability level and nonsignificant respectively.

Table 6. mean comparison of LER for, corn and mung bean forage dry yield under different mixing ratios and different levels of vermicompost

	Maize dry forage yield (LER)	Mung dry forage yield (LER)	Total ratio (LER)
Vermicompost levels			
V_1	0.761^{c}	0.39^{ab}	1.15^{c}
V_2	0.775^{b}	0.4^{b}	1.17^{b}
V_3	0.780^{a}	0.41^{a}	1.19^{a}
Mixing ratio			
25% maize-75% mung	0.62^{c}	0.48^{a}	1.1^{b}
50% maize-50% mung	0.65^{b}	0.3^{b}	0.95^{c}
75% maize-25% mung	0.16^{a}	0.34^{c}	1.5^{a}

Note. Same letters in each column represent no significant differences in the level of 5 percent.

4. Discussion

Tadesse (2016) results showed the highest and lowest corn height of 245.5 and 190.8 cm were related to 50-50 cultivated cowpea and maize, and monoculture of corn. The results of Dahmardeh et al. (2011) also revealed that the maize was taller in the 25%-75% ratio of cowpea and maize in intercropping. Nakh Zari Moqadam et al. (2016) reported that in barley and green pea intercropping, the competitive ratio of barley was more than green pea, so that ratio was higher in 75% barley and 25% green pea. Pak Gohar and Ghanbari (2013) stated that the difference in depth, development and root density in grain and legumes intercropping causes differences in the absorption of nutrients. Since corn grows faster and has a larger root system, the absorption of nutrients, especially monovalent elements such as nitrogen, works better (Carruthers et al., 2000). The result is a lack of soil nitrogen and legume's required nitrogen-fixing increases, so corn easily uses soil nitrogen sources and growth will be more (Hauggaard-Nieson et al., 2001).

Saha et al. (2008) reported that due to the increase in soybeans biological function in the application of vermicompost, compost is high due to enzymatic activity. Tests have shown that using compost levels (15, 30, 45 and 60 tons per hectare) had significant effects on corn forage yield and shoots dry weight and application of 60 tons of compost per hectare showed significant differences with other treatments (Memari, 2004). Based on research on intercropping agriculture, increasing the performance time, it is possible that each plant involved will occupy different ecological niches and use environmental resources differently and also have minimal interaction (Strydhorst et al., 2008). The researchers said increasing the nutrients in the soil will increase nutrient uptake and plants can grow better and increase yield (Mgbeze & Abu, 2010). On the other hand, Ghanbari-Bonjar (2000) stated that intercropping of wheat and beans causes higher efficiency of PAR than a monoculture, and also the absorption of solar radiation, which is wasted probably due to poor growth of plants at the beginning of the season and the aging of beans at the end of the season. Intercropping of these two used light more efficiently and increased dry matter.

The researchers said that in maize and amaranth intercropping, manure application significantly increased concentrations of crude protein. Since the protein concentration is directly related to the concentration of plants nitrogen, more nitrogen absorption in the intercropping and manure application can increase the concentration of protein in maize (Olorunnismo & Ayodelet, 2009). In this regard, also expressed by increasing the amount of compost, nitrogen levels increased. The highest nitrogen levels was related to 45 and 60 tons per hectare and the lowest was in control. Based on research, if compost is well processed, the carbon to nitrogen ratio will decrease from 10 to 1, and by adding the compost to the soil, not only will the amount of nitrogen in the soil, because of being consumed by microorganisms, not decrease, but plant growth will improve by adding to the stock of nitrogen in the soil (Sullivan et al., 2002).

In search of forage barley intercropping with faba bean, green pea and lupin, Strydhorst et al. (2008) concluded that bean-barley, lupin-barley and pea-barley had 64, 27 and 55 percent more protein respectively than barley monoculture. According to the results of this research, it can be stated that intercropping of legumes and cereals can increases the crude protein content. It can be due to increasing the yield and maize protein content. In the intercropping of cowpea and maize, the effect of culture on concentrations of corn crude protein was significant and with the increase of planting cowpea in intercropping of maize, concentrations of maize crude protein increased. Monoculture of maize had the least crude protein atmospheric nitrogen fixation by legumes and transfering it to maize in intercropping can cause an increase in protein than corn monoculture (Muhammad et al., 2006). Since the main reason for increased protein in the forage is increased nitrogen, presumably nitrogen transfer from legume to the grass in intercropping is done through direct leakage, moulting nodes, root rot, leaf ecological washing and leaf decomposition.

Lima (Filho, 2000) showed that high LER in intercropping is connected with many factors like increasing in light absorption as well as maize partial equity ratio to cowpea that represents the more competitiveness and dominance of maize to the legumes.

Hakim et al. (1992) reported in the evaluation of intercropping of maize and beans that both species were negatively affected by intercropping, although these plants compensate each other's yield and therefore the LER in all intercropping treatments was more than one, which shows how useful intercropping is. Grasses and legumes have morphological differences and thus create a different spread; and better use of light sources, food and soil different depths can cause the LER greater than one indicating that probably corn and mung were complementary.

Results showed that vermicompost increased forage dry matter, forage protein percent and plant height in maize. Mung and maize intercropping increased maize crude protein concentration and decreased maize dry matter yield compared to monoculture.

Maize, beans and bitter vetch intercropping decreased beans and bitter vetch biomass and grain yield and reduced the number of seeds per plant in bitter vetch and increased concentrations of crude protein in bean seeds. Manure application increased beans biological yield, grain yield, number of seeds per pod, seed weight and crude protein. Intercropping of maize and bitter vetch and manure application increased bitter vetch's harvest index, number of pods per plant, grain weight and shoots and seeds crude protein concentration. In general, to increase the quantity and quality of forage, the intercropping of maize with beans and application of 60 tons of manure per hectare in the study area and similar conditions can be recommended.

Table 7. Comparison of some traits in maize and mung bean intercropping and application of vermicompost

Vermicompost	Mixing ratio	Mung bean dry forage yield (kg/h)	Maize dry forage yield (kg/h)	Mung bean protein (%)	Maize protein (%)	Maize height (cm)
V_1	100% maize	-	13001 ^{g}	-	12.5 ^{g}	122.5 ^{h}
V_1	100% mung	1820 ^{h}	13111 ^{g}	20 ^{d}	-	-
V_1	50% maize-50% mung	1870 ^{h}	13600 ^{f}	19.5 ^{e}	16 ^{c}	124 ^{g}
V_1	25% maize-75% mung	1943 ^{eg}	13820 ^{f}	20 ^{d}	15 ^{cd}	130.2 ^{c}
V_1	75% maize-25% mung	1921 ^{eg}	14111 ^{e}	18 ^{f}	14 ^{ef}	128.5 ^{cde}
V_2	100% maize	-	14233 ^{de}	-	14.4 ^{c}	126.4 ^{c}
V_2	100% mung	2000 ^{d}	14520 ^{de}	23.2 ^{ab}	-	-
V_2	50% maize-50% mung	1980 ^{e}	14700 ^{d}	21.5 ^{bc}	17.5 ^{ab}	125.7 ^{f}
V_2	25% maize-75% mung	2521 ^{ab}	14980 ^{d}	21.7 ^{bc}	16.9 ^{bc}	138.1 ^{b}
V_2	75% maize-25% mung	1981 ^{e}	15009 ^{cd}	21 ^{bc}	15.5 ^{cd}	136.2 ^{cd}
V_3	100% maize	-	15122 ^{c}	-	15 ^{d}	136.1 ^{d}
V_3	100% mung	2500 ^{b}	15034 ^{c}	24.8 ^{a}	-	-
V_3	50% maize-50% mung	2550 ^{ab}	17102 ^{a}	22.5 ^{b}	18.2 ^{a}	138.4 ^{c}
V_3	25% maize-75% mung	2600 ^{a}	17007 ^{a}	22.9 ^{b}	17.7 ^{b}	142.8 ^{a}
V_3	75% maize-25% mung	2200 ^{c}	16401 ^{b}	21.4 ^{c}	16.5 ^{c}	140.6 ^{b}

Note. Same letters in each column represent.

References

Bachman, G. R., & Metzger, J. R. (2008). Growth of bedding plants in commercial potting substrate amended with vermicompost. *Bioresource. Technol., 99*, 3155-3161. https://doi.org/10.1016/j.biortech.2007.05.069

Carruthers, K., Prithiviraj, B., Fe, O., Cloutler, D., Martin, R. C., & Smith, D. L. (2000). Intercropping corn with soybean, lupin and forages: Yield component responses. *European Journal of Agronomy, 12*, 163-115. https://doi.org/10.1016/S1161-0301(99)00051-9

Dahmardeh, M., Ghanbri, A., Syahsar, B. A., & Ramroudi, M. (2011). Evalution of forage yield and protein content of maize and cowpea intercropping. *Iranian Journal of Crop Sciences, 4*, 658-670.

Fenandez-Aparicio, M., Sillero, J. C., & Rubials, D. (2007). Intercropping with cereals reduces infection by *Orobanche crenata* in legumes. *Crop Protection, 26*, 1166-1172. https://doi.org/10.1016/j.cropro.2006.10.012

Ghanbari-Bonjar, H. (2000). *Intercropped wheat (Triticum aestivum) and bean as a low-input forage* (PhD thesis. Wye College, University of London).

Ghosh, P. K., Manna, M. C., Bandyopadhyay, K. K., Ajay, A. K., Tripathi, R. H., Wanjari, K. M., … Subba Rao, A. (2006). Interspecific interaction and nutrient use in soybean-sorghum intercropping system. *Agronomy Journal, 98*(4), 1097-1108. https://doi.org/10.2134/agronj2005.0328

Hauggaard-Nieson, H., Ambus, P., & Jensen, E. S. (2001). Temporal and spatial distribution of roots and ompetition for nitrogen in pea-barley intercrops. A field studies employing 23P techniques. *Plant and Soil, 236*, 63-74. https://doi.org/10.1023/A:1011909414400

Jonathan, D. C. (2008). Intercropping with maize in sub-Arid Regions. *Crop Science, 41*, 432-440.

Lithourgidis, A. S., Dhima, K. V., Vasilakoglou, I. B., Dordas, C. A., & Yiakoulaki, M. D. (2007). Sustainable production of barley and wheat by intercropping common vetch. *Agronomy for Sustainable Development, 27*, 95-99. https://doi.org/10.1051/agro:2006033

Maboeta, M. S., & Rensburg, L. (2003). Vermicomposting of industrially produced woodchips and sewage sludge utilizing *Eisenia fetida*. *Ecotoxicol. Environ. Safety, 56*, 265-270. https://doi.org/10.1016/S0147-6513(02)00101-X

Mkhabelaa, M. S., & Warman, P. R. (2005). The influence of municipal solid waste compost on yield, soil phosphorous availability and uptake by two vegetable crops grown in a Pugwash sandy loam soil in Nova Scotia. *Agr. Ecosys. Environ., 106*, 57-67. https://doi.org/10.1016/j.agee.2004.07.014

Muhammad, I., Rafig, M., Sultan, A., Akram, M., & Arifgoher, M. (2006). Green fodder yield andquality evolution of maize and cowpea sown alone and in combination. *Journal of Agricultural Research, 44*(1), 121-129.

Olorunnismo, O. A., & Ayodelet, O. J. (2009). Effects of intercropping and fertilizer application on the yield and nutritive value of maize and amaranth forages in Nigeria. *Grass and Forage Science, 64*, 413-420. https://doi.org/10.1111/j.1365-2494.2009.00706.x

Rahimi, M., Mazaheri, D., Khodabandeh, N., & Hedarri Sharifabad, H. (2002). Effect of yield and yield components maize/soybean Intercropping. *Pajohesh and Sazandegi, 55*, 45-51.

Strydhorst, S. M., King, J. R., Lopetinsky, K. J., & Harker, K. N. (2008). Forage potential of intercropping barley with faba bean, lupine, or field pea. *Agronomy Journal, 100*, 182-190. https://doi.org/10.2134/agrojnl2007.0197

Strydhorst, S. M., King, J. R., Lopetinsky, K. J., & Harker, K. N. (2008). Forage potential of intercropping barley with faba bean, lupine, or field pea. *Agronomy Journal, 100*, 182-190. https://doi.org/10.2134/agrojnl2007.0197

Tadesse, A. (2016). Evaluation and Demonstration of Haricot Bean (*Phaseolus vulgaris* L.) intercropped with Maize (*Zea Mays* L.) On Yield and Yield Component of Maize and Common Bean at South Ari, Southern Ethiopia. *Global Journal of Chemistry, 2*(2).

Timothy, G., Reeves, S., Rayaram, M., Ginkelb, V., Trethowan, R., Joachim Braum, H., & Cassady, K. (2000). New wheats for a secure, sustainable future. *Agronomy Journal, 96*, 1013-1020.

Copyrights