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Influence of Green Manuring From Different Cover Crops and Farm Yard Manures on Quantitative and Qualitative Characteristics of Forage Corn in Low Input Farming

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ABSTRACT

An appropriate sustainable agricultural technology system is an important technical support of the promotion of sustainable agricultural development. Properly management of residues can warrant the improvement of sustainability in crop productivity. This experiment was conducted to study the effects of green and from manures of forage and chemical characteristics of corn. The research was conducted in 2011 at Experimental Field of Islamic Azad University, Isfahan (Khorasgan) Branch, Isfahan, Iran. A strip layout in randomized complete block design with three replications was used. The experiment was related to the effects of green manures of barley, rye, triticale and clover, two levels of farm yard manure, namely, 30 and 60 t/ha and one treatment of chemical fertilizer as control. Treatment were arranged in main strip and decomposition time of manures in two levels, one and four weeks after returning to the soil were considered subplots. Cover crops had significant influence on stem diameter, ear height, final plant height, leaf and stem fresh weights, stem and ear dry weights, fresh forage yield, leaf nitrate and protein content. Moreover, fresh forage yield, biological yield, leaf nitrate, stem nitrate, protein and ash were influenced by different managements. The highest plant height, leaf, ear and stem fresh weights, ear, stem and ear dry weights were related to barley green manure treatment. The maximum stem diameter, plant height, ear fresh weight, leaf, stem and ear dry weights were obtained in the treatment of four weeks of residue retention. The highest biological yield and fiber percentage of forage corn were observed in the treatment of residue retention for four weeks and crop residue incorporation, respectively. Besides, there were no significant differences for characteristics between mentioned above treatments and residue burning. The highest fresh forage yield, protein and ash percentages were achieved in residue burning treatment. In conclusion, it seems that residue burning accompanied with usage of triticale as a green manure was the best choice to achieve high quality, but for obtaining the highest fresh forage yield and biological yield of forage corn, triticale plantation can be replaced by barley.

***Keywords*:** Cover crops, Manure, Green manure, Forage corn.

INTRODUCTION

Corn (*Zea mays L.)* is one of the most important cereal crops grown in Iran (Khoshkharam *et al*., 2010; Soleymani *et al*., 2011; Soleymani *et al*., 2012). Green manuring refers to addition of green plant tissue to the soil (Selvi and Kalpana, 2009). One of the key factors in increasing the yield and quality of crops is appropriate manuring (Talgre *et al*., 2010; Soleymani and Shahrajabian, 2012; Soleymani and Shahrajabian, 2013; Soleymani *et al*., 2013; Shahrajabian and Soleymani, 2017). In the present economical situation, the sale prices of crops have decreased considerably compared to previous years, whereas the prices of pesticides and fertilizers have risen, leaving the farmers with fewer financial resources (Berry *et al*., 2002; Soleymani *et al*., 2010; Soleymani and Shahrajabian, 2011; Shahrajabian *et al*., 2011). Also, a high soil N fertility from incorportated green manure crops, implies risk of N leaching (Askegaard *et al*., 2005; Ogbaji *et al*., 2013).

Goncalves *et al*. (2007) reported that the different residue management treatments resulted in pronounce effects on growth of crops. The intensive tillage practices employing inversion implements such as mould board plough results in losses of surface crop residue and subsequent loss of soil organic carbon (SOC) from soil aggregates. Also, long-term biomass removal results in reduced total biomass yields over time due to nutrient depletion, as reflected by increased nitrogen stress on subsequent crops (Meki *et al*., 2013; Shahrajabian *et al*., 2017; Soleymani and Shahrajabian, 2017; Ogbaji *et al*., 2018). Erenstein (2011) illustrated that retention of crop residues is generally considered advantageous because it recycles both organic matter and nutrients back to the soil. Unlike in Europe, USA, Canada and Australia, the influence of different tillage systems and crop residue management under semi-arid region in center of Iran have been scarcely studied. It is necessary to quantify the widespread impacts of tillage and residue burning, to encourage well-informed management decisions that will guide the future of sustainable agriculture and crop production in semi-arid regions (Soleymani *et al*., 2016). The objective of this study was to determine the influence of green manures and crop residue management on yield and yield components of forage corn.

MATERIALS AND METHODS

The investigation was conducted in 2011 at Agricultural Research Farm of Islamic Azad University of Isfahan (Khorasgan) Branch, (Latitude $32^{o}40^{/}$ N, longitude $51^{o}58^{/}$ E, and 1570 m elevation) Isfahan, Iran. A strip layout in randomized complete block design with three replications was used. This experiment was conducted to study the effects of green manure and farm yard manure on forage yield and chemical characteristics of corn. Green manures included barley, rye, triticale and clover, two levels of farm yard manure namely, 30 and 60 t/ha and one treatment of chemical fertilization as a control treatment were arranged in main strip and decomposition time of manures in two levels, one and four weeks after returning to soil, were considered as sub plots. The amount of total dry weight of manure was measured with equation number 1.

Total required dry amount of manure =
The amount of required nitrogen × Available nitrogen (%) × Nitrogen percentage of manure (1)

Manure was mixed with soil immediately after spreading. All crops were returned to the soil with mouldboard ploughing, before heading stage for cereals, and at 10% flowering stage for clover. Six- row plots, 7.5 m long were used. Within row distance was 0.14 m. These distances were maintained for achieving 95000 plants/ha. The first irrigation was done after plantation, the second one was done four days after planting and other irrigations were done on the basis of 75 ml evaporation from pan class A. Weeds were controlled by hand weeding. Half of urea fertilizer was used after the second irrigation and the other half was used at reproductive phase. Dry matter yield of crops was considered as the yield potential of the treatments. The amount of nitrogen was calculated by Kjeldahl analysis from dry and ground samples and then nitrogen was multiplied by 6.25 to determine protein content. Nitrate content was also determined by spectrophotometer (410 nm) and salicylic acid method. Ash content was determined by incinerating the samples in muffle furnace at 550^{o}C for 4 h. Neutral detergent fiber was measured by the method of Van Soest and Wine (1968) with enzyme addition. Analysis of variance was used to determine the significant differences. Duncan 's multiple range test was used for mean comparison. All of the statistics analyses were performed with SAS program.

RESULTS AND DISCUSSION

Cover crop had significant influence on stem diameter, ear height, plant height, leaf and, stem fresh weights, stem and ear dry weights; however, ear fresh weight and leaf dry weight were not significantly affected by cover crop. Different kinds of management had significant effects on stem diameter, ear height, plant height, leaf and stem fresh weights, ear fresh weight, and leaf, stem and ear dry weights. Interaction effects of cover crop and management had significant influence on stem diameter, ear height, plant height, leaf, stem, ear fresh weights, stem and ear dry weights. Crop residues, in general, are parts of the plants left in the field after crops have been harvested. These materials have been regarded as waste materials that require disposal for many years, but it has become increasingly realized that they are important natural resources. The recycling of crop residue has the advantage of converting the surplur farm waste into useful product for meeting nutrient requirement of crops. The highest ear height, plant height, leaf and ear fresh weights and stem and ear dry weights were related to barley green manure treatment. The maximum stem diameter, ear height, plant height, ear fresh weight, and leaf, stem and ear dry weights were obtained in the treatment of four weeks residue retention. To conclude, in this experiment four weeks of residue retention accompanied by using of barley as a green manure led to the highest yield and yield components of forage corn. Soil fertility building by such means requires a long term integrated approach, rather than the short term and targeted solutions common in conventional agriculture.

Table 1. Mean comparisons for stem diameter, ear height, final plant height, leaf, stem and, ear fresh weight, leaf, stem and ear dry weights.

Treatment	Stem diameter (mm)	Plant ear height (cm)	Final plant height (cm)	Leaf fresh weight (kg/ha)	Stem fresh weight (kg/ha)	Ear fresh weight (kg/ha)	Leaf dry weight (kg/ha)	Stem dry weight (kg/ha)	Ear dry weight (kg/ha)
Cover crops									
Barley	25.27a	115.52a	223.60a	1419.42a	5104.5a	3106.5a	463.56a	985.28a	809.42a
Rye	25.76a	110.48a	223.43a	954.90b	3964.4b	2614.2ab	441.40a	847.12b	668.18ab
Triticale	23.59b	98.36b	119.93b	800.80b	3747.6b	2258.1b	489.27a	882.91b	535.23b
Management									
Residue burning	24.48b	110.28b	224.91a	1241.63a	4797.8a	2873.0a	527.28a	951.21b	690.55a
Crop residue incorporation	24.62b	105.74c	212.05b	925.52b	2359.3b	2359.3b	466.87c	824.96c	608.68b
One week of residue retention	24.25b	102.56d	197.06c	955.17b	2382.6b	2382.6b	432.67c	824.28c	617.26b
Four weeks of residue retention	26.14a	113.90a	228.58a	1110.90a	3023.4a	3023.4a	471.85b	1019.95a	767.27a

For each experimental factor means with a common letter within each column do not differ significantly ($p<0.05$)

Cover crop had significant influence on fresh forage yield, and leaf nitrate and protein content, however, biological yield, stem nitrate, fiber and ash percentages were not significantly affected by cover crop. Fresh forage yield, biological yield, leaf and stem nitrate, protein and ash percentages were influenced by different managements. Although, cover crop and management interaction had significant influence on fresh forage yield, but biological yield, leaf nitrate, fiber and ash parentages were not affected by this interaction. In spite the fact that the highest fresh forage yield and biological yield of forage corn were related to barley green manure treatment, the highest leaf nitrate was found for this treatment. In contrast, forage corn plantation after rye also obtained the maximum stem nitrate, which had no significant difference with treatment of barley cultivation as green manure. Furthermore, there was no significant differences in fiber percentage among treatments. Despite the fact that triticale green manure obtained the highest protein and ash percentages, there was no significant difference in ash percentage among treatments. The maximum biological yield and fiber percentage of forage corn were observed in the treatments of residue retention for four weeks and crop residue incorporation, respectively; moreover, there were no significant differences for these characteristics between above mentioned treatments and residue burning treatment. The highest fresh forage yield, and protein and ash percentages were achieved in residue burning treatment accompanied with usage of triticale as a green manure. Although this agronomic practice was the best choice to achieve high forage quality, but for obtaining the most fresh forage yield and biological yield of forage corn, triticale plantation can be replaced by barley.

Table 2. Mean comparisons for fresh forage crops yield, biological yield, leaf and stem nitrate, fiber (ENDF), protein and ash percentages.

Treatment	Fresh forage yield (t/ha)	Biological yield (t/ha)	Leaf nitrate (ppm)	Stem nitrate (ppm)	Fiber (ENDF) (%)	Protein (%)	Ash (%)
Cover crops							
Barley	96.305a	22.583a	102.94a	88.90ab	26.09a	6.899b	9.070a
Rye	75.333b	19.567ab	92.85b	90.69a	26.40a	7.115b	9.012a
Triticale	68.068b	19.071b	87.50c	83.94b	26.09a	8.043a	9.315a
Management							
Residue burning	89.125a	21.693a	108.61a	115.40a	26.15ab	8.687a	9.657a
Crop residue incorporation	72.086b	18.605b	95.39b	80.73b	26.72a	7.318b	9.210b
One week of residue retention	71.748b	18.742b	299.83c	76.88b	25.50b	6.526c	8.535d
Four weeks of residue retention	86.646a	22.590a	90.42d	75.35b	26.39ab	6.877bc	9.127c

For each experimental factor means with a common letter within each column do not differ significantly ($p<0.05$)

CONCLUSION

Complete residue removal or burning should be avoided due to concerns for reduced soil organic matter levels, environmental and soil erosion problems. Green manuring is an age-old practice used for supplying nitrogen to crop plants. The intensive cropping system, heavy input technology, environmental degradation and other related problems, again encouraged its re-inclusion in plant nutrient supply system. our results showed that cover crop had significant influence on stem diameter, ear height, final plant height, leaf fresh weight, and stem fresh weights, stem and ear dry weights, fresh forage yield, leaf nitrate and protein contents, moreover, fresh forage yield, biological yield, stem and leaf nitrate, and protein and ash percentage were influenced by different managements. The highest plant height, leaf and stem fresh weights, ear fresh weight, and stem and ear dry weights were related to treatment of cultivation of barley as a green manure. The maximum stem diameter, plant height, ear fresh weight, leaf, stem and ear dry weights were obtained in the treatment of four weeks for residue retention. The highest biological yield and fiber percentage of forage corn were observed in treatments of residue retention for four weeks and crop residue incorporation, respectively. Besides, there were no significant differences for these characteristics between above mentioned treatments and residue burning treatment. The highest fresh forage yield, protein percentage and ash percentage were achieved in residue burning treatments. In conclusion, it seems that residue burning accompanied with usage of triticale as a green manure was the best choice to achieve high forage quality, but for obtaining the highest fresh forage yield and biological yield of forage corn, triticale plantation can be replaced by barley. In near future, the importance of these types of investigation will become increasingly important with increasing environmental concerns and obtaining of healthy products.

REFERENCES

Askegaard M, Olesen JE, Kristensen K. 2005. Nitrate leaching from organic arable crop rotations: effects of location, manure and catch crop. Soil Use Manage, 21: 181-188.

Berry PM, Sylvester-Bradley R, Philipps L, Hatch DJ, Cuttle SP, Rayns FW, Goslin P. 2002. Is the productivity of organic farms restricted by the supply available nitrogen? Soil Use Manage, 18: 248-255.

Erenstein O. 2011. Cropping systems and crop residue management in the Trans-Gangetic Plains: Issues and Challenges for conservation agriculture from village surveys. Agricultural Systems, 104: 54-62.

Goncalves JLM, Wichert MCP, Gava JL, Masetto AV, Junior JCA, Serrano MIP, Mello SLM. 2007. Soil fertility and growth of Eucalyptus grandis in Brazil under different residue management practices. Southern Hemisphere Forestry Journal, 69(2): 95-102.

Khoshkharam M, Rezaei A, Soleymani A, Shahrajabian MH. 2010. Effects of tillage and residue management on yield components and yield of maize in second cropping after barley. Research on Crops, 11(3): 659-666.

Meki MN, Snider JL, Kiniry JR, Raper RL, Rocateli AC. 2013. Energy sorghum biomass harvest thresholds and tillage effects on soil organic carbon and bulk density. Industrial Crops and Products, 43: 172-182.

Ogbaji PP, Antigha NRB, Akpan-Idiok AU, Li J, Shahrajabian MH. 2013. Irrigation suitability of Onwu river flood plain soils in Cross River State, Nigeria. Journal of Food, Agriculture and Environment, 11(2): 999-1003.

Ogbaji PO, Li J, Xue X, Shahrajabian MH, Egrinya Eneji A. 2018. Mineralogical and textural characteristics of soil of Hancheng and Shannxi Province. Communication in Soil Science and Plant Analysis, 1-5.

Selvi RV, Kalpana R. 2009. Potentials of green manure in integrated nutrient management for rice-a review. Agricultural Review, 30: 40-47.

Shahrajabian MH, Soleymani A, Naranjani L. 2011. Grain yield and forage characteristics of forage sorghum under different plant densities and nitrogen leves in second cropping after barley in Isfahan, Iran. Research on Crops, 12(1): 68-78.

Shahrajabian MH, Soleymani A, Ogbaji PO, Xue X. 2017. Impact of different irrigation managements on soil water consumption, grain yield and seed protein, phosphorus and potassium of winter wheat. Cercetari Agronomice in Moldova, 3(171): 5-13.

Shahrajabian MH, Soleymani A. 2017. Responses of physiolgocial indices of forage sorghum under different plant populations in various nitrogen fertilizer treatments. International Journal of Plant & Soil Science, 15(2): 1-8.

Soleymani A, Shahri MM, Shahrajabian MH, Naranjani L. 2010. Responses of cultivars of canola to sulfur fertilizer and plant densities under climatic condition of Gorgan region, Iran. Journal of Food, Agriculture and Environment, 8(3/4 part 1): 298-304.

Soleymani A, Shahrajabian MH. 2011. The influence of different planting dates, plant densities on yield and yield components of rice on the basis of different nitrogen levels. International Journal of Agronomy and Plant Production, 2(2): 80-83.

Soleymani A, Asghar Khajedin A, Shahrajabian MH. 2011. Grain yield and yield components of corn (*Zea mays L.*) hybrids in response to planting dates in semi-arid region in Isfahan. Research on Crops, 12(1): 45-52.

Soleymani A, Shahrajabian MH. 2012. The effects of Fe, Mn, and Zn foliar application on yield, ash and protein percentage of forage sorghum in climatic condition of Esfahan. International Journal of Biology, 4(3): 92.

Soleymani A, Khoshkharam M, Shahrajabian MH. 2012. Germination rate and initial growth of silage corn grown under various fertility systems. Research on Crops, 13(3): 1035-1038.

Soleymani A, Shahrajabian MH. 2013. The effects of planting dates on growth and development stages of different cultivars of wheat in semi arid condition of Iran. International Journal of Agronomy and Plant Production, 4(3): 537-540.

Soleymani A, Shahrajabian MH, Naranjani L. 2013. Effect of planting dates and different levels of nitrogen on seed yield and yield components of nuts sunflower (*Helianthus annuus* L.). African Journal of Agricultural Research, 8(46): 5802-5805.

Soleymani A, Shahrajabian MH, Khoshkharam M. 2016. The impact of barley residue management and tillage on forage maize. Romanian Agricultural Research, 33: 1-13.

Soleymani A, Shahrajabian MH. 2017. Assessment of ET-HS model for estimating crop water demand and its effects on yield and yield components of barley and wheat in semi-arid region of Iran. Cercetari Agronomice in Moldova, 4(127): 37-49.

Talgre L, Lauringson E, Makke A. 2010. Amounts of nitrogen and carbon returned to soil depending on green manure and the effect on winter wheat yield. Agronomy Research 8 (Special Issue II): 487-492.

Van Soest PJ, Wine RH. 1968. Determination of lignin and cellulose in acid-detergent fiber with permanganate. Journal Association Official Analytical Chemists, 51: 780-785.