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Effects of Some Forage Crops and Mixture on Sunflower Yield and Soil Nitrogen Content

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This research was conducted in Dardanos Research Center in Canakkale during 2003-2005 growing seasons. The aim of this research was to investigate effects of forage crops (common vetch, common vetch + barley, narbonne vetch) on soil nitrogen contents and sunflower yield. Two years results showed that leguminous and common vetch + barley mixture had greater biomass and higher N concentration and therefore, it increased sunflower seed yield. When forage crops were removed from the field for hay, it still supplied N for the sunflower. Sunflower seed yield increased 10.57 to 16.09 % after mixing as green manure and harvesting as hay, respectively compared to control.

Key Words: Common vetch, Narbonne vetch, Nitrogen, Sunflower.

INTRODUCTION

Sunflower is one of the five most important oil crops in the world and the first in Turkey[1]. It is rotated generally with wheat in Turkey. This type of rotation increases pest and disease problems. Moreover rotation with the same crops has negative effects on soil physical and chemical properties. Sunflower reduces soil organic matter. As a result the yield and soil quality decreases.

Forage crops conserve soil organic C and N, where organic matter in soil is considerably low such as Turkey. A mixture of legume and cereals would be ideal to supply N to improve soil fertility and crop productivity as well as reduce N leaching. Soil productivity can be increased with long term use of forage crops.

Winter forage crops can uptake residual soil N and reduce nitrate leaching. On the other hand legumes can fix atmospheric N and reduce N fertilizer required for succeeding crops[2].

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Sunflower is usually sown in the late April or May in Turkey. Thus, the field is left bare until sowing date of sunflower. However in south and west of Turkey, the winter is warm enough to grow some legumes and their mixtures with cereals for hay or green manure. Therefore the objective of this research was to evaluate the effects of common vetch, common vetch + barley mixture, narbonne vetch grown as hay and green manure on sunflower yield and soil nitrogen.

EXPERIMENTAL

This research was carried out in the 2003-2005 growing seasons at the Dardanos Research Center in Canakkale, Turkey. Canakkale province has a moderate climate. The mean annual rainfall is 615.5 mm, temperature is 14.8 ºC. Initial soil samples were taken from replicated sampling points from 0-20 cm depths of each plot. Soil $CaCO_3$ was 13.5 %, P was 46.68 ppm and pH was 7.69. Soil organic C contents ranged from 2.62 to 3.40 %. The soil at the site is clay loam[3]. The site has a slope of 1-2 %. Each plot was 24 m^2 (4.0 m × 6.0 m). Common vetch variety Urem 79, narbonne vetch variety L-628 and barley variety six-rowed variety were used. Experimental design was a randomized block design with three replications. Treatments are described below:

1. Common vetch for hay
2. Common vetch + barley mixture for hay
3. Narbonne vetch for hay
4. Common vetch for green manure
5. Common vetch + barley mixtures for green manure
6. Narbonne vetch for green manure
7. 300 kg ha^{-1} 20-20-0 NPK commercial fertilizer
8. 600 kg ha^{-1} 20-20-0 NPK commercial fertilizer
9. Control (without any application)

Treatments 4, 5 and 6 were incorporated into soil as green manure, shoots in treatments 1, 2 and 3 were cut for hay and roots were incorporated into the soil in spring. Soil remained as follow during the winter before Sunflower (*Helianthus annus* L.) seeding in treatments 7, 8 and 9.

All treatments were tilled in the fall and were disked once to a depth of 8 to 12 cm for seed bed preparation in October. Forage crops were seeded with 40 cm row spacing on 17 November, 2003 and 19 November, 2004 for the first and second year of the experiment, respectively.

Forage crop above ground biomass in appropriate treatments were cut when they reached to 10 % flowering periods. Biomasses of all treatments were determined by hand-clipped from one 1 m^2 quadrat per plot located in a representative area without weeds at two times. Samples were oven dried at 70 ºC until constant weight and biomass was expressed on a dry matter basis.

Cover crops were incorporated by disc harrowing followed by mouldboard ploughing. Incorporation of green manure crops were done 2 weeks before Sunflower plantation in both years.

Sunflower (*Heliantus annuus* L. var. sunbro) were sown on 5 May 2004 at a seed rate of about 50 thousand seeds ha^{-1} with 70 cm row spacing. Plants were thinned 15 d after sowing. Sunflower seed yield was determined in late September of each year.

Plant measurements: Forage crop biomass was sampled immediately before killing them. Two 1 m^2 sub samples of above ground plant biomass were taken from the three center rows of each experimental unit. Plant biomass was dried for 3 d at 65 ºC and then weighed.

Soil samplings: Soil samples were collected from the plots before and after the termination of forage crops to monitor residue decomposition at 0 to 0.20 m depth.

Analysis: Soil organic C was analyzed using the dichromate oxidation technique[4]; total N was determined by steam distillation by Kjeldahl automatic analyzer using the Bremner method[5]; soil texture by hydrometer method[6]; pH, EC and CEC using the methods described in Soil Survey Staff[7].

Statistical analysis: Analyses of variance were performed using MINITAB[8]. Fishers LSD (5 %) test was used to separate means of measurements. Data were analyzed separately for 2004 and 2005.

RESULTS AND DISCUSSION

There were significant differences in the dry biomass among cover crops. Total forage crop biomass prior to incorporation ranged from 1.1 to 2.4 Mg DM ha^{-1} (Table-1). Average of 2 years data showed that, narbonne vetch for green manure and common vetch + barley mixture for hay had the greatest biomass in 2004 and 2005, respectively. N concentration of forage crops varied from 2.5 to 3.1 %. Common vetch for hay and for green manure had the highest N contents in 2004 and 2005 due to increased N fixation. Vetch + barley mixture had lower N concentration (2.7 %) than other treatments. On the other hand due to its great biomass (2079 kg ha^{-1}) much more N has been added to the soil from this treatment (55.5 kg N ha^{-1}). It was reported that growing legume in mixture with a small grain generally dilutes tissue N concentration for the herbage[9]. Table-2 indicates that average N concentration of common vetch for green manure was 3.1 % however it reduced to 2.7 % when common vetch mixed with barley.

The present results showed that all plots with common vetch significantly increased soil N contents in 2004 (Table-2). Similar results have also been found in 2005. However, increments in N contents were more distinct in treatments narbonne vetch for hay (3) and common vetch for green manure (4) where both shoots and roots were incorporated into the soil.

TABLE-1
DRY MATTER YIELD AND PLANT PROTEIN CONTENTS

Treat.	Dry biomass (kg ha^{-1})			Plant N (%)			N yield (kg N ha^{-1})		
	2004	2005	Two years	2004	2005	Two years	2004	2005	Two years
1	1371	1183	1277b	3.10	3.00	3.1 a	43	35	39
2	1882	2277	2079a	2.90	2.50	2.7 c	55	57	56
3	2049	2056	2052a	2.70	2.70	2.7 c	55	56	55
4	1242	1226	1234b	3.00	3.10	3.1 a	37	38	38
5	1869	1915	1892a	2.90	2.80	2.8 b	54	54	54
6	2396	1819	2108a	2.80	2.70	2.8 c	67	49	58
Mean	1802	1746	1774	2.90	2.80	2.9	52	49	51

Columns labeled with the different letters are significantly different at $p \leq 0.05$ according to Fisher's LSD test.

TABLE-2
EFFECTS OF TREATMENTS ON SOIL TOTAL N CONTENTS (%) IN 2004 AND 2005

	Treatments	2003	2004
Nitrogen	1	0.10 A	0.10 B
	2	0.09 A	0.10 B
	3	0.07 B	0.08 C
	4	0.11 A	0.12 A
	5	0.11 A	0.12 A
	6	0.08 B	0.10 B
	7	0.07 B	0.09 BC
	8	0.09 A	0.11 AB
	9	0.10 A	0.10 B

Columns labeled with the different letters are significantly different at $p \leq 0.05$ according to Fisher's LSD test.

When soil total N contents are compared in green manure and hay before and after the incorporation of cover crops, it can be concluded that soil N contents significantly increased after the incorporation of cover crops to the soil due to mineralization of organic N (Table-3).

TABLE-3
TOTAL N CONTENTS IN SOIL BEFORE (1) AND AFTER (2) INCORPORATION OF COVER CROPS IN 2004 AND 2005

	Sampling time	2003	2004
Nitrogen	1	0.08 B	0.10 B
	2	0.10 A	0.11 A

Columns labeled with the different letters are significantly different at $p \leq 0.05$ according to Fisher's LSD test.

Average seed yield in 2005 was 2154 kg ha^{-1} while it was 1779 kg ha^{-1} in 2004 (Table-4) because of higher precipitation in 2005 than 2004. Average of 2 years data showed that proceeding CVB-R and CVR-RS treatments significantly increased sunflower seed yield.

The lowest seed yield was obtained from control treatment (1810 kg ha^{-1}). Treatment numbers 1, 2, 3, 4, 5, 6, 7, 8 increased seed yield by % 15.06, 11.55, 10.99, 16.09, 12.04, 10.57, 1.05, 10.72 compared to control.

TABLE-4
SUNFLOWER SEED YIELD IN 2004 AND 2005

Treatments	Seed yield (kg ha^{-1})		
	2004	2005	Two years
1	1883 AB	2172 CD	2028 AB
2	1677 E	2353 AB	2015 ABC
3	1914 A	2269 BC	2092 A
4	1707 DE	2457 A	2082 A
5	1825 ABC	2001 EF	1913 CD
6	1793 BCD	2184 CD	1989 ABC
7	1693 DE	1963 EF	1829 DE
8	1784 BCD	2095 DE	1940 BC
9	1736 CDE	1893 F	1810 E
Mean	1779	2154	1966

Columns labeled with the different letters are significantly different at $p \leq 0.05$ according to Fisher's LSD test.

Odhiambo and Bomke[10] reported that nitrogen accumulation increased by 3 to 47 kg ha^{-1} for late-planted cover crops. The N content in the roots has been estimated to be 10 % of total crop N for vetch, 20 % for crimson clover, 25 % for fall rye[11]. When we compared common vetch + barley mixtures for green manure and common vetch + barley mixtures for hay, it can be accounted that roots released 1.84 kg N ha^{-1} to the soil which is approximately 3.5 % of total crop N.

Ozyazici and Manga[12] stated that under irrigated conditions in Turkey, sunflower grain yield were 4938 and 4925 kg ha^{-1} in narbonne vetch and common vetch treatments, respectively. These green manure plants increased the yield of sunflower by 36.8 and 36.4 %. These values twice as much of values obtained from our research due to dry and non-irrigated conditions. However common vetch + barley mixtures for hay and common vetch + barley mixtures for green manure had the highest sunflower seed yields due to greater N obtained from these cover crops.

According to Sainju *et al.*[13] N content in common vetch was between 76 to 165 kg ha^{-1}. It was found that N concentration of common vetch for hay and common vetch for green manure were higher than other treatments.

However due to their higher biomasses, common vetch + barley mixtures for green manure, common vetch + barley mixtures for hay, narbonne vetch for green manure and narbonne vetch for hay treatments added much more N to the soil systems.

Conclusion

It was concluded that (1) leguminous and small grain cover crop mixture had greater biomass and higher N concentration and increases succeeding sunflower seed yield. (2) Even cover crop shoots are removed from the field for animal feed (as hay in spring), it still supply N benefits for the succeeding plants (3) for this reason, farmers obtain double benefit when they include cover crop in their crop rotation.

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REFERENCES

1. B. Gurbuz, M.D. Kaya and A. Demirtola, Ayçiçegi Tarimi, Hasad Yayincilik, Istanbul, p. 102 (2003).
2. W.L. Hargrove, *Agron. J.*, **78**, 70 (1986).
3. H. Ozcan, H. Ekinci, Y. Kavdir, O. Yuksel and H. Kaptan, Dardanos Yerleskesi Alan Topraklari. COMU Pub. No 39, Canakkale (2003).
4. D.W. Nelson and L.E. Sommers, in eds.: D.L. Sparks, A.L. Page, P.A. Helmke, R.H. Loeppert, P.N. Soltanpour, M.A. Tabatabai, C.T. Johnson and M.E. Sumner, Total Carbon, Organic Carbon and Organic Matter, Methods of Soil Analysis, Part-3, Chemical Methods, Soil Sci. Soc. Am. Book Ser. 5. SSSA, Madison, WI, pp. 961-1010 (1996).
5. J.M. Bremner, in ed.: D.L. Sparks, A.L. Page, P.A. Helmeke, R.H. Loepert and J.M. Bartels, Nitrogen-Total, In: Methods of Soil Analysis, Part-3. Chemical Methods, SSSA Book Set. 5. Soil Science Society of America, Madison, W, po. 1085-1121 (1996).
6. W. Gee and J.W. Bauder, in ed.: A. Klute, Particle-Size Analysis, Methods of Soil Analysis: Part 1. Physical and Mineralogical Methods, ASA Monograph 9, pp. 383-411 (1986).
7. Soil Survey Staff, Soil Survey Laboratory Methods Manual. Soil Survey Investigations Report No. 42. Version 3.0, National Soil Survey Center, Lincoln, NE (1996).
8. http://www.minitab.com/products/minitab/14/
9. T. Griffin, M. Liebman and J. Jemison, *Agron. J.*, **92**, 144 (2000).
10. J.J.O. Odhiambo and A.A. Bomke, *Agron. J.*, **93**, 299 (2001).
11. P.R. Shipley, J.J. Meisinger and A.M. Decker, *Agron. J.*, **84**, 869 (1992).
12. M.A. Ozyazici and I. Manga, *Turkish J. Agric. For.*, **24**, 95 (2000).
13. U.M. Sainju, W.F. Whitehead and B.P. Singh, *Agron. J.*, **97**, 1403 (2005).

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