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# Second crop alternatives for winter period in wheat-cotton and cotton-cotton cropping pattern in Mediterranean ecologies

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***RESUME –*** *"Une culture intercalaire hivernale dans les rotations blé-coton et coton-coton en régions méditerranéennes". L'absence de culture hivernale pendant 5 à 6 mois dans les rotations traditionnelles de coton-coton et de coton-blé dans les régions côtières méditerranéennes, permet d'envisager durant cette période des cultures intercalaires de légumineuses et de graminées annuelles en mélange en vue d'une production de fourrage. Ceci répondrait à la demande pressante des éleveurs de bétail. Afin de déterminer les potentialités de différentes cultures annuelles et de leurs associations, deux expériences ont été réalisées dans la région de Bornova/Izmir. Des cultures d'*Hordeum vulgare*, de* Triticale*, de* Lolium multiflorum*, de* Vicia sativa*, de* Vicia faba *et de* Trifolium resupinatum *ainsi que chaque une des associations d'une graminée et d'une légumineuse ont été comparées pour leur rendement en poids frais et sec et en protéines brutes. Il ressort que les associations suivantes :* Hordeum vulgare *+* Vicia sativa, Hordeum vulgare *+* Vicia faba*,* Lolium multiflorum *+* Vicia sativa *et* Hordeum vulgare + Trifolum resupinatum*, ont données les meilleurs résultats à la fois au niveau agronomique et au niveau économique.*

***Mots-clés :*** *Rotation coton-blé, écologie méditerranéenne.*

## Introduction

Since there is a gap of 5-6 months in the fields during winter period in traditional cotton-cotton or cotton-wheat rotation in coastal regions, there are possibilities of using annual legumes and cereal mixtures as second crop for forage production and soil renovation. Legumes such as vetches (*Vicia* sp), annual clovers (*Trifolium resupinatum, Trifolium fragiferum*) and cereals such as barley (*Hordeum vulgare*), oats (*Avena sativa*) and triticale are promising alternatives for additional rainfed roughage production during the period between October and April in succeeding year. Farmworth (1972) indicated the significance of utilizing above mentioned period to grow barley and its satisfactory dry matter yield of 7800 kg/ha. Avcioglu (1979) indicated that *Vicia sativa* mixed with barley or oats at a rate of 50% gave highest green herbage, dry matter and crude protein yields of 41 $t.ha^{-1}$, 8 $t.ha^{-1}$ and 1.2 $t.ha^{-1}$, respectively. Many research workers experimented wheat, barley and oats separately or mixed with common or hairy vetch and showed the possibilities of producing 9500-6000 kg/ha dry matter and 650-450 $kg.ha^{-1}$ crude protein (Aydin and Tosun, 1991; Soya *et al.*, 1988). Pejic (1976) tested hairy vetch with rye or barley in different rate of mixtures and found that the mixture containing 75% vetch + 25% rye had the highest hay yield of 6300 $kg.ha^{-1}$. He also stated that crude protein yield was highest in the mixtures of 50 % vetch + 50% rye. Moreno *et al.* (1975) reported that green matter and dry matter yields of common vetch were 36,600 $kg.ha^{-1}$ and 7100 $kg.ha^{-1}$, respectively. Many research workers demonstrated that higher rates of legumes in mixtures increased hay quality whereas cereals were more effective on quantity of biomass (Gonzales *et al.*, 1967; Munzur, 1989; Soya *et al.*, 1988). The aim of these article was to evaluate the results of different experiments conducted with annual legumes and cereals grown alone or in mixture in the area and to discuss their significance for the future of local animal husbandry farming in terms of yield performances during winter period under Mediterranean ecological conditions.

## Materials and methods

Consecutive experiments on annual legume+cereal mixtures were conducted in Izmir region between 1976 and 2000. Two of them were chosen to compare the performances of different crop materials. Both of the studies were carried out on silty-clay loam soil with 7.8 pH in Bornova experimental field of Ege University (27°E, 38°N) located at about 2 m a.s.l. with typical Mediterranean climate characteristics.

### Experiment A: Effect of cutting dates on various winter forage crop mixtures

Meteorological data of growing periods in 1996-97 and 1997-98 were monthly mean temperature 10.6-10.6℃, total precipitation 502-461 mm, monthly mean relative humidity 64.8%-64.6%, monthly mean duration of sunshine 5.4-5.4 h.day$^{-1}$ respectively. 3 different cutting dates (1$^{st}$ April, 16$^{th}$ April and 1$^{st}$ May) and 8 crop alternatives (*Vicia sativa, Trifolium resupinatum, Hordeum vulgare, Lolium multiflorum* and their mixtures (including only one legume and one grass) were applied. Experimental design was a split-plot arrangement of a randomized complete block with 4 replications. The cutting times were main plots, and crop alternatives were subplots. Each sub-plot consisted of 14 rows 20 cm apart and 5 m in length. 20 kg.ha$^{-1}$ N fertilizer were applied as starting rate before seeding which was done at 21.11.1996 in the first year and at 25.12.1997 in second year. Samples of three different cutting dates were evaluated in terms of green herbage, dry matter and crude protein yields.

### Experiment B: Effect of seeding techniques on various winter forage crop mixtures

Meteorological data of growing periods in 1991-1992 were monthly mean temperature 10.5℃, total precipitation 273 mm, monthly mean relative humidity 59.9%, monthly mean duration of sunshine 6.2 h.day$^{-1}$, respectively. 2 different seeding technique (sowing in same or separate rows) and 4 different crop alternatives (*Vicia sativa, Vicia faba*, *Hordeum vulgare* and *Triticale* mixtures including only one legume and one cereal in each combination) were applied. The experimental design was a randomized complete block with 4 replications. Each plot consisted of 10 rows 20 cm apart and 5 m in length. 100 kg.ha$^{-1}$ N-P-K (15:15:15) fertilizer were applied as starting rate before seeding which was done at 12.10.1991. The field trial was harvested at 22.04.1992. Samples of two different seeding techniques were evaluated in terms of green herbage, dry matter and crude protein yields.

## Results and discussion

### Experiment A

The results of the effect of different cutting dates on green herbage, dry matter and crude protein yields of crop alternatives were presented in Table 1. The cutting time x crop alternative interaction was significant, indicating that crop alternatives did respond differentially to the cutting dates. Highest green herbage yield was observed in *Vicia sativa* + *Hordeum vulgare* and *Vicia sativa + Lolium multiflorum* mixtures cut at 1 May whereas the yield of *Hordeum vulgare* cut at 1 April was lowest. In general, late cuttings were for more successful than early cuttings and the mixtures including *Vicia sativa* and *Lolium multiflorum* had higher yield performances. These results were in agreement with the indications of Farmworth (1972) and Avcioglu (1979), but our yield values were far more than their results. Highest dry matter yields were obtained at 1 May cutting in *Vicia sativa + Hordeum vulgare* and *Vicia sativa + Lolium multiflorum* mixtures whereas *Trifolium resupinatum* had the lowest dry matter yield at first cutting. Considering the significance of cutting time x crop alternative interaction, it might be concluded that dry matter yields of crop alternatives have been highly affected by cutting dates similar to green herbage yields. From this viewpoint it could be also suggested that late cuttings were favorable for better growth rates which allow the crops to produce higher biomass and to store richer dry matter content (Beckmann, 1998). Data related to dry matter yields were also in agreement with the results of many other research workers (Gonzales *et al*., 1967; Pejic, 1976) but our yield values were extremely high due to the exceptional climatic conditions in 1997 and 1998. The data related to crude protein yields was also similar to those of green herbage and dry matter yields. As expected, *Vicia sativa + Hordeum vulgare* mixture cut at 1 May had the highest crude protein yield. Pejic (1976) reported that rate of legumes in mixtures increased crude protein content of the material and hairy vetch was a proper component of this kind of mixtures. Moreno *et al*. (1975)'s indications were also similar**.**

### Experiment B

The results of effect of sowing technique on green herbage, dry matter and crude protein yields of legume + cereal mixtures were presented in Table 2. Statistical analysis indicated the significance of variation among the legume + cereal mixtures in terms of green herbage yield and *Vicia*

*faba+Hordeum vulgare* and *Vicia sativa+Hordeum vulgare* mixtures possessed highest values. There was not any significant difference between sowing techniques. Green herbage yield results also indicated the superiority of mixtures including *Hordeum vulgare* over others. This results were in agreement with the findings of Gonzales *et al.* (1967). Dry matter yield results were almost similar to green matter yields, except *Vicia sativa+Hordeum vulgare* mixtures being almost equal to *Vicia faba+Triticale* mixtures. Dry matter yield of *Vicia sativa+Triticale* mixtures was least among other mixtures. Crude protein yields of different mixtures displayed again the superiority of *Vicia faba+Hordeum vulgare* and *Vicia sativa* mixtures over the others, indicating the better performance of *Hordeum vulgare* in the mixtures compared to *Triticale*.

Table 1. Effects of different cutting dates on green herbage, dry matter and crude protein yields of crop alternatives (kg.ha$^{-1}$) (two year average, 1997-1998)

| | Cutting Dates (CD) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ---------- Green Herbage Yield ---------- | | | | ---------- Dry Matter Yield ---------- | | | |
| Crop Alternatives(CA) | 1 April | 16 April | 1 May | Mean | 1 April | 16 April | 1 May | Mean |
| *V. sativa* | 37,730 | 40,420 | 74,720 | 50,957 | 5,280 | 6,800 | 14,880 | 8,987 |
| *T. resupinatum* | 35,610 | 39,640 | 49,610 | 41,620 | 3,730 | 4,660 | 6,900 | 5,097 |
| *H. vulgare* | 21,670 | 28,620 | 40,270 | 30,187 | 4,080 | 6,460 | 10,710 | 7,083 |
| *L. italicum* | 26,320 | 29,520 | 33,300 | 29,713 | 4,060 | 5,450 | 6,730 | 5,413 |
| *V. sativa+H. vulgare* | 49,020 | 66,390 | 99,400 | 71,603 | 7,920 | 12,710 | 21,660 | 14,097 |
| *V. sativa+L. italicum* | 64,820 | 74,420 | 100,060 | 79,767 | 10,450 | 13,010 | 19,350 | 14,270 |
| *T. resupinatum+ H. vulgare* | 56,650 | 69,200 | 92,510 | 72,787 | 7,980 | 10,510 | 18,300 | 12,263 |
| *T. resupinatum+L. italicum* | 51,530 | 67,560 | 93,840 | 70,977 | 6,950 | 10,260 | 15,590 | 10,933 |
| Mean | 42,919 | 51,971 | 72,964 | - | 6,306 | 8,733 | 14,265 | - |
| LSD (0.05) | CD: 960 | CA: 2,120 | CD x CA: 3,680 | | CD: 290 | CA: 460 | CD x CA: 800 | |

| | ---------- Crude Protein Yield ---------- | | | |
|---|---|---|---|---|
| Crop Alternatives(CA) | 1 April | 16 April | 1 May | Mean |
| *V. sativa* | 1,183 | 1,322 | 2,537 | 1,681 |
| *T. resupinatum* | 865 | 947 | 1,249 | 1,020 |
| *H. vulgare* | 549 | 698 | 874 | 707 |
| *L. italicum* | 548 | 582 | 564 | 565 |
| *V. sativa+H. vulgare* | 1,377 | 1,846 | 2,640 | 1,954 |
| *V. sativa+L. italicum* | 1,896 | 1,980 | 2,486 | 2,121 |
| *T. resupinatum+H. vulgare* | 1,398 | 1,699 | 2,194 | 1,764 |
| *T. resupinatum+L. italicum* | 1,218 | 1,513 | 1,946 | 1,559 |
| Mean | 1,129 | 1,323 | 1,811 | - |
| LSD (0.05) | CD: 46 | CA: 76 | CD x CA: 131 | |

Table 2. Effects of sowing technique on the green herbage, dry matter and crude protein yields of different legume+cereal mixtures (kg.ha$^{-1}$)

| | Sowing Technique | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Mixture | *Same Rows* | *Separate Rows* | Mean | *Same Rows* | *Separate Rows* | Mean | *Same Rows* | *Separate Rows* | Mean |
| | Green Herbage Yield | | | *Dry Matter Yield* | | | Crude Protein Yield | | |
| *Vicia faba+ Hordeum vulgare* | 39,300 | 38,850 | 39,075 A | 8,253 | 8,172 | 8,213 A | 913 | 922 | 918 A |
| *Vicia faba+ Triticale* | 28,650 | 32,550 | 30,600 B | 6,324 | 7,181 | 6,753 B | 591 | 685 | 638 B |
| *Vicia sativa+ Hordeum vulgare* | 39,500 | 42,070 | 40,785 A | 6,761 | 7,223 | 6,992 B | 872 | 937 | 905 A |
| *Vicia sativa+ Triticale* | 28,070 | 28,110 | 28,090 B | 5,095 | 5,185 | 5,140 C | 615 | 620 | 618 B |
| Mean | 33,880 | 35,395 | - | 6,608 | 6,940 | - | 748 | 791 | - |

Different letters indicate significant differences at $p<0.05$

## Conclusions

There are many possibilities of using different legume+cereal mixtures as second crop for winter period in wheat-cotton and cotton-cotton cropping systems in Mediterranean ecologies. This type of cultivation, in another word crop rotation means an additional rainfed roughage production and supply for the urgent demand of livestock husbandry sector. *Vicia sativa* and *Trifolium resupinatum* seems to be the most effective legumes for these kind of mixtures and *Hordeum vulgare* and *Lolium multiflorum* are the most successful partners. Late cuttings till early May should be the most favourable stages in terms of green herbage, dry matter and crude protein yields in Izmir region.

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