Maejo Int. J. Sci. Technol. **2017**, *11*(03), 219-225

Maejo International
Journal of Science and Technology

ISSN 1905-7873
Available online at www.mijst.mju.ac.th

Short Communication

Smooth vetch (*Vicia dasycarpa* L.) as a suitable crop for mixed planting with barley in semi-arid regions

Mahmoud Pouryousef [1, *], Khoshnood Alizadeh [2] and Jaime A. Teixeira da Silva [3]

[1] Department of Agronomy, Mahabad Branch, Islamic Azad University, Mahabad, Iran
[2] Dryland Agricultural Research Institute (DARI), Agricultural Research Education and Extension Organisation (AREEO), Maragheh, Iran
[3] P. O. Box 7, Miki-cho Post Office, Ikenobe 3011-2, Kagawa-ken, 761-0799, Japan
* Corresponding author, e-mail: Dr.Pooryoosef@gmail.com; tel: +98-9144811694; fax: +98-421-2222069

Received: 16 September 2016 / Accepted: 23 September 2017 / Published: 6 October 2017

Abstract: Forage resources during late summer in semi-arid regions are limited, but this limitation could be alleviated by cultivating suitable crops. In this study three seeding rates of smooth vetch (*Vicia dasycarpa* cv. 'Maragheh') and grass pea (*Lathyrus sativus* cv. 'Naghadeh local') were tested as pure and mixed stands with shattered barley seeds that were harvested in mid-July from north-west Iran. Several agronomic and quality-related traits were determined when the legumes reached the flowering stage, which coincided with the initial creamy stages of barley. The choice of crop significantly ($P < 0.01$) affected dry biomass and crude protein. The highest dry biomass (9 t/ha) was obtained in a mixture of barley and vetch at 200 seeds/m². The highest protein levels (>20%) were obtained in pure stands of vetch and grass pea although the levels dropped to 18% in some mixtures with barley. The mixture of barley and vetch at 200 seeds/m² resulted in the highest land equivalent ratio (1.71) while the highest relative value total (1.35) was obtained from a mixed crop of barley and vetch at 250 seeds/m². Thus, a mixed crop of barley and smooth vetch at 200-250 seeds/m² is the best crop combination when planted as a summer crop in semi-arid regions.

Keywords: smooth vetch, *Vicia dasycarpa*, annual legumes, biculture, grass pea, *Lathyrus Sativus*, intercropping

INTRODUCTION

Forage production does not meet the increase in livestock demands in semi-arid areas of Iran [1]. The growth in population, urbanisation and income that fuel the increase in meat and milk consumption is expected to continue, creating a veritable livestock revolution [2]. Global gains in meat consumption more than doubled (from 129 to 285 million ton) from the early 1980s until 2008 and increases in Asia accounted for a 100 million ton of the more than 150 million ton increase [3]. It has been estimated that about 75% of extremely poor farmers rely on livestock for their livelihood [4]. Despite the advantages of using legumes as food and feed crops, legume cultivation has not met desired expectations, and production remains below that of other crops such as cereals. This underperformance is accompanied by the progressive replacement of traditional farming systems with industrialised, largely cereal-based systems that heavily rely upon fossil fuels [5].

Climate change and decreasing water resources have limited forage production in semi-arid areas of Iran [1]. It is believed that forage crops cannot be introduced or expanded into areas where other crops including cereals are grown since these are defined as strategic crops in most countries including Iran. It is thus necessary to look for new opportunities and solutions.

Cereals are dominant crops in semi-arid regions of Iran. There is a brief gap between the harvesting of cereals in early July and the planting of new crops in early October when fields are normally left fallow. This three-month gap could be a window of opportunity in terms of production. There is almost no rainfall during July to late September in these areas [6]. Thus, if it is possible to provide some irrigation water to these areas, the possibility of producing forage crops is realistic. However, such crops would have to grow quickly and complete their reproductive cycle within a maximum of 60 days so that planting of normal winter crops can start in early October. Grass pea could be used for this purpose although its biomass production is not economical [7].

After harvesting cereals including wheat and barley, there is a considerable seed bank of shattered seeds remaining behind that is useless during summer and is usually consumed by birds or insects [8]. The rate of shattering is strongly dependent on the harvesting method and the machinery used, although it is believed that at least 5% of barley and wheat grain are shattered during harvest [8]. Barley production is around 3000 kg/ha under irrigated conditions in semi-arid areas [1] and thus 5% shattering would be the optimum seeding level for such areas. Planting suitable crops just after harvesting cereals could theoretically result in a useful mixed crop. Mixed cropping systems involving cereals with forage legumes can improve the quantity and quality of fodder more than that of a pure cereal crop stand [9, 10]. Considerable variation has been reported in forage yields of improved vetches (*Vicia* spp.) and grass pea (*Lathyrus* spp.) under semi-arid conditions [11] in which smooth vetch and grass pea could grow and flower during 50-60 days as spring crops in cold, dryland conditions. Rapid growth and low input demands of smooth vetch and grass pea would fit perfectly into the summer fallow in Iranian semi-arid areas. Planting vetch and grass pea with minimum tillage just after cereals are harvested using minimal irrigation could lead to a mixture of cereals and legumes. However, the appropriate legume and planting densities have not yet been explored. This is the objective of this study.

Even though intercropping efficiency can be assessed by multiple functions and/or other parameters [12], the most basic tool is land equivalent ratio (LER), which is determined using the grain yield, dry matter and mass density of an individual crop. The other is relative value total (RVT), which assigns economic value to a crop [12]. If the yield of a crop derived from polyculture is greater than that from monoculture, then it has a greater economic value, and an RVT score greater than 1 indicates that the intercrop increase yields economically. The present work evaluates the biomass yield and protein content of the mixture of shattered barley and a local variety of smooth vetch and grass pea as a potential summer crop at three seeding ratios.

MATERIALS AND METHODS

An experimental field (20 m × 20 m) was manually tilled and then an appropriate N-P fertiliser (40 kg/ha N + 20 kg/ha P_2O_5) was applied uniformly to the soil just after harvesting of barley (*Hordeum vulgare* cv. 'Makoii') at the Malekan Agricultural Research Station (37° 8′ N, 46° 4′ E and 1285 m above sea level) in north-west Iran in mid-July, 2011. The density of shattered barley seeds after harvest was estimated to be 400 seeds/m² by direct counting using sampling quadrates. The shattering rate was assumed to be homogenous throughout the field and was verified by testing replications of pure barley stands, which were not found to be statistically different. Seeds of smooth vetch (*Vicia dasycarpa* cv. 'Maragheh') and grass pea (*Lathyrus sativus* cv. 'Naghadeh local') at three densities (150, 200 and 250 seeds/m²) were immediately planted and irrigated (200 m^3/ha) at the end of July. This experiment was carried out in a randomised complete block design with 13 treatments (as indicated in Figure 1) comprising 6 mixed stands and 7 pure stands with three replications.

The size of each plot was 10 m^2. Pure vetch and grass pea stands were created by manually eliminating germinated barley and other weeds. Wet biomass was harvested when pods started to form on legume plants. This coincided with the milky stage of barley. At that time, samples from a randomly selected 1-m^2 area of each plot were cut to ground level. Sub-samples of wet biomass (0.3 kg wet biomass/plot) were dried at 70°C for 48 hr to determine dry matter yield. Nitrogen content (N) was determined on the same dried sub-samples of each plot using micro-Kjeldahl procedure as described by Nelson and Sommers [13]; then crude protein concentration was calculated as N×6.25.

LER was calculated according to Willey [14] and RVT was estimated according to Vandermeer [12]:

$$\text{LER} = \frac{\text{P1}}{\text{M1}} + \frac{\text{P2}}{\text{M2}}$$

$$\text{RVT} = \frac{(\text{aP1} + \text{bP2})}{\text{aM1}}$$

where P1 and P2 are yields of two different crops in the intercropping, M1 and M2 are yields of these crops in mono-cropping, and a and b are market prices (in US dollars) for crops 1 and 2 respectively.

SPSS [15] software was used for analysis of variance (ANOVA). Treatment means were separated by the Duncan's multiple range test (DMRT) at P = 0.05.

RESULTS AND DISCUSSION

A mixture of vetch and grass pea and barley in this experiment was harvested in mid-September 2011. The land was left free for a required period of time to prepare for the subsequent winter crop. Doing so guaranteed that no interaction existed between both vetch and grass pea and barley as the summer crop and major winter crops, the presence of which could be a limiting factor in the selection of suitable crops. ANOVA (Table 1) shows that the choice of crop affects dry biomass and crude protein significantly ($P < 0.01$). Little information is available regarding vetch and grass pea as suitable summer crops as well as their capacity for mixing with barley in order to

Maejo Int. J. Sci. Technol. **2017**, *11*(03), 219-225

produce summer forage. Our results show the potential of producing biomass during summer in the north-west of Iran, where there is less than 300 mm of annual precipitation. This area of Iran is classified as semi-arid area and is known for its short spring and dry summer [1].

Table 1. ANOVA of some studied characteristics of different mixtures of vetch and grass pea and barley as summer crop

Source of Variation	Degree of freedom	Mean of Squares	
		Dry biomass	Protein
Block	2	1.94	1.67
Treatment	12	5.84*	5.84*
Error	24	1.09	1.18

* significant at 1% probability level

This study shows a wide variation in forage production potential among the different mixtures of vetch and grass pea and barley. The highest dry biomass (9 t/ha) was obtained from a mixture of barley and vetch at 200 seeds/m² (Figure 1), which is double that obtained from the pure barley stand. The high vetch biomass relative to grass pea indicates that vetch is effective in a mixed crop with barley, possibly because smooth vetch used barley as a growth support. This is not possible when grass pea alone is used [7]. However, competition during mixed cropping may also contribute to an increase in the growth capacity of smooth vetch, probably because of its creeping growth type. In mixed cropping, an attempt is made to minimise the degree of competition between crop species, which might adversely affect yield and quality, while creating competition by the intercrop to suppress weeds [16], thus maximising yield. Relatively higher dry matter production of smooth vetch was also reported in rainfed conditions [17].

The highest protein content (>20%) was obtained in pure stands of vetch and grass pea although 18% protein was observed in some mixtures with barley (Figure 2). Pure legume stands are expected to have higher protein content. However, the relatively low dry mass production in pure stands of annual legumes in general, and smooth vetch in particular, limits the advantage conferred by the relatively higher protein content in the pure stands. In addition, harvesting is easier in mixed stands since barley offers a physical support to legumes in general. It is difficult to harvest pure stands of smooth vetch, which does not have an erect growth form and usually tends to lodge.

The LER values were found to be greater than 1 for all mixtures of annual legumes and barley (Table 2). The highest LER value (1.71) was recorded for the mixed crop of barley and vetch at 200 seeds/m², indicating that an additional 0.71 unit of land would be needed to obtain an equal yield if vetch and barley were to be planted as pure stands. The lowest LER value (1.39) was obtained from the mixed crop of barley and grass pea at 150 seeds/m² whereby intercropping had 0.39 ha profitability in terms of land usage.

The RVT values of all treatments were also found to be greater than 1 (Table 2), indicating that mixed cropping resulted in an economic advantage. The range of RVT lay between 1.02-1.35, indicating a 2-31% economic advantage in our experimental plots. A mixed crop of an annual legume and barley therefore seems to increase economic revenue and profitability of farmlands. A 10% higher profit was also observed [18] based on the relative LER value in a maize-okra intercrop compared to monocrops. Intercropping maize-groundnut was found to produce higher LER and RVT than individual crops [19], emphasising the advantage of intercropping.

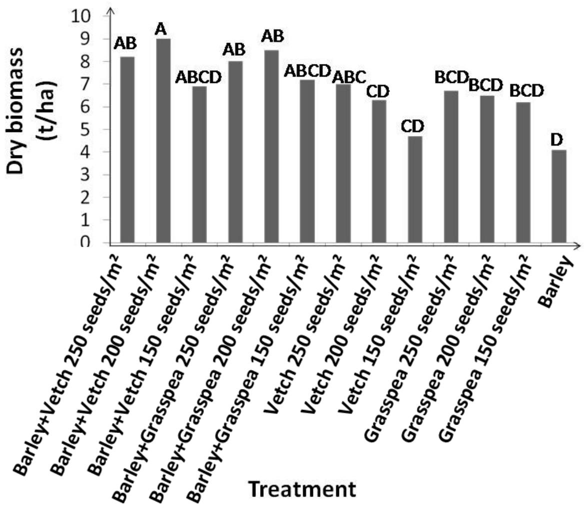

Figure 1. Mean dry matter production (t/ha) from different mixtures of vetch and grass pea and barley as summer crop. Means with the same letters are not significantly different according to DMRT (P = 0.05) across all treatments.

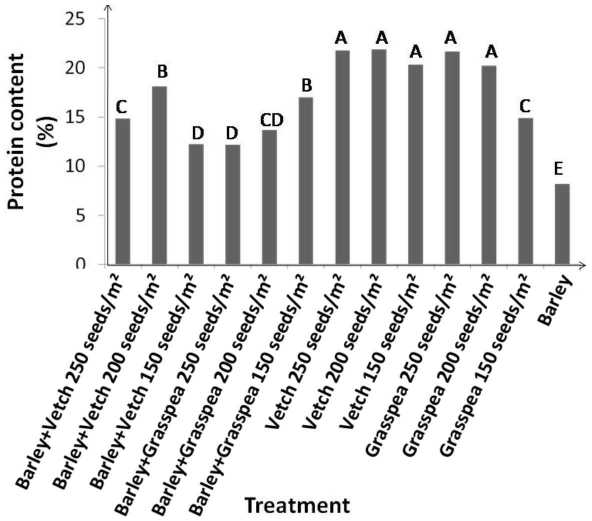

Figure 2. Mean crude protein (%) in different mixtures of vetch and grass pea and barley as summer crop. Means with the same letters are not significantly different according to DMRT (P = 0.05) across all treatments

Table 2. LER and RVT values for different mixtures of vetch and grass pea and barley as summer crop

Treatment	LER	RVT
Barley + vetch at 250 seeds/m^2	1.45	1.35
Barley + vetch at 200 seeds/m^2	1.71	1.26
Barley + vetch at 150 seeds/m^2	1.57	1.25
Barley + grass pea at 250 seeds/m^2	1.45	1.05
Barley + grass pea at 200 seeds/m^2	1.59	1.15
Barley + grass pea at 150 seeds/m^2	1.39	1.02

CONCLUSIONS

Mixtures of barley and vetch and grass pea in general gave good results with RVT and LER values of greater than 1 in this study. The cultivation of vetch at 200-250 seeds/m^2 just after barley was harvested gave good quantity and quality of forage in the semi-arid regions of Iran. This could serve as an economic alternative to summer fallow. In addition, as it coincides with the end of the growing season, it is especially recommended for local farmers who have not been able to produce sufficient forage during the growing season. Controlling summer weeds, recycling shattered cereal grains and enhancing soil fertility using vetch and/or grass pea as a summer crop are our future research activities.

REFERENCES

1. K. Ahmadi, H. Golizadeh, H. Ebadzadeh, R. Hoseinpour, F. Hatami, B. Fazli, A. Kazemian and M. Rafiee, "Agricultural statistics. Ministry of Jihad-e-Agriculture, Iran" **2014**, http://amar.maj.ir (Accessed: September 2016).
2. C. L. Delgado, "Rising consumption of meat and milk in developing countries has created a new food revolution", *J. Nutr.*, **2003**, *133*, 3907-3910.
3. U. Pica-Ciamarra, L. Tasciotti, J. Otte and A. Zezza, "Livestock assets, livestock income and rural households: Cross-country evidence from household surveys", Joint Paper of the World Bank, FAO, AU-IBAR and ILRI, **2011**, http://www.africalivestockdata.org (Accessed: October 2011).
4. Food and Agriculture Organization, "The State of Food and Agriculture: Livestock in the Balance", FAO, Rome, **2009**.
5. D. Rubiales and A. Mikic, "Introduction: Legumes in sustainable agriculture", *Crit. Rev. Plant Sci.*, **2014**, *34*, 2-3.
6. R. Modarres and V. P. R. da Silva, "Rainfall trends in arid and semi-arid regions of Iran", *J. Arid Environ.*, **2007**, *70*, 344-355.
7. K. Alizadeh, M. Pooryousef and A. S. Kumar, "Bi-culturing of grass pea and barley in the semi-arid regions of Iran", *Legume Res.*, **2014**, *37*, 98-100.
8. J. Lamei, K. Alizadeh, J. A. Teixeira da Silva and M. J. Taghaddosi, "*Vicia panonica*: A suitable cover crop for winter fallow in cold regions of Iran", *Plant Stress*, **2011**, *6*, 73-76.
9. D. R. Mpairwe, E. N. Sabiti, N. N. Umunna, A. Tegegne and P. Osuji, "Integration of forage legumes with cereal crops: 1. Effects of supplementation with graded levels of lablab hay on voluntary food intake, digestibility, milk yield and milk composition of crossbred cows fed maize-lablab stover or oats-vetch hay *ad libitum*", *Livestock Product. Sci.*, **2003**, *79*, 193-212.
10. N. N. Umunna, P. O. Osuji, H. Khalili, I. V. Nsahlai and S. Crosse, "Comparative feeding value of forages from two cereal-legume based cropping systems for beef production of crossbred (*Bos taurus* X *Bos indicus*) steers and subsequent performance of underfed and realimented steers", *Animal Sci.*, **1995**, *61*, 35-42.
11. K. Alizadeh, "Feed legumes status in drylands of Iran – limitations and opportunities", Proceedings of 5th International Conference for Food Legumes Research, **2010,** Antalya, Turkey.
12. J. H. Vandermeer, "The Ecology of Intercropping", Cambridge University Press, New York, **1989**.
13. D. W. Nelson and L. E. Sommers, "Determination of total nitrogen in plant material", *Agron. J.*, **1973**, *65*, 109-112.
14. R. W. Willey, "Intercropping - its importance and research needs. Part I. Competition and yield advantages", *Field Crops Abst.*, **1979**, *32*, 1-10.
15. SPSS Inc., **"**SPSS Base 8.0 Applications Guide", SPSS Incorporated, Chicago, **1998.**
16. D. T. Baumann, L. Bastiaans and M. J. Kropff, "Competition and crop performance in a leek-celery intercropping system", *Crop Sci.*, **2001**, *41*, 764-774.
17. K. Alizadeh and J. A. Teixeira da Silva, "Mixed cropping of annual feed legumes with barley improves feed quantity and crude protein content under dry-land conditions", *Maejo Int. J. Sci. Technol.*, **2013**, *7*, 42-47.

Maejo Int. J. Sci. Technol. **2017**, *11*(03), 219-225

18. R. A. Alabi and A. O. Esobhawan, “Relative economic value of maize-okra intercrops in rainforest zone, Nigeria”, *J. Central Europ. Agric.*, **2006**, *7*, 433-438.
19. P. K. Ghosh, “Growth, yield, competition and economics of groundnut/cereal fodder intercropping systems in the semi-arid tropics of India”, *Field Crops Res.*, **2004**, *88*, 227-237.