UNIVERSITY OF JORDAN
FACULTY OF GRADUATE STUDIES
GRADUATE DEPARTMENT OF BIOLOGICAL AND AGRICULTURAL SCIENCES AND NATURAL RESOURCES

PRODUCTIVITY AND QUALITY OF SOME ANNUAL FORAGE LEGUMES AS INFLUENCED BY DIFFERENT GROWTH STAGES AND CUTTING TREATMENTS IN RAINFED AREAS

BY

JAMAL YOUSEF MAHMOUD AYAD

Under Supervision of

Dr. BASSAM SNOBAR

A Thesis Submitted
In Partial Fulfillment Of
The Requirements For The Degree
Of
MASTER OF SCIENCE
IN PLANT PRODUCTION

Faculty of Graduate Studies

University of Jordan

May, 1992

The examining committee considers this thesis satisfactory and acceptable for the award of **Master of Science Degree** in the Department of Plant Production, Faculty of Agriculture, University of Jordan.

1. **Dr. Bassam Snobar**, Professor
   Chairman of the committee

   Bassam Snobar --

2. **Dr. Abdel Majid El Tell**, Associate Professor
   Member of the committee

   Abdelmajid Tell --

3. **Dr. Nasri Haddad**, Associate Professor
   Member of the committee

   ----

4. **Dr. Muhammed Harb**, Associate Professor
   Member of the committee

   Dr M. Harb --

5. **Dr. Muhammed Ababneh**
   Member of the committee

   Dr. M. Ababneh --

TO

MY PARENTS

A C K N O W L E D G M E N T

I would like to express my deep gratitude and appreciation to my advisor Prof. Dr. Bassam Snobar for his guidance, encouragement, helpful suggestions and supervision throughout this study.

Special thanks to Dr. Nasri Haddad, Dr. Abdel Majid Ell Tell, Dr. Muhammed Harb, and Dr. Muhammed Ababneh for their valuable suggestions, helpful remarks, and reviewing the manuscript.

I am grateful to Prof. Dr. Samir Salem for his frequent useful insights that he provided throughout most of the research phases.

My formal expression of esteem is also extended to Dr. A. Abd El Moneim (ICARDA) for his contribution during problem suggestions .

Deep appreciation and great thanks are extended to the Jordan/Australia Dry Land Farming Project whose help, financial support, and cooperation made this work possible.

Deep appreciation and great thanks are extended to the authorities at the International Center for Agricultural Research in the Dry Areas (ICARDA) and Ministry of Agriculture, Amman Jordan, For their cooperation and offering me the required amounts of seeds for the different species included in the study.

Last but not the least, my deepest gratitude are due to my family and colleagues, especially K. Abu Sway for their help, encouragement and advice throughout this study.

ABSTRACT

In Jordan, two defoliation trials were conducted at M'shagar location to evaluate the effect of growth stages and cutting height treatments on forage yield and quality of seven annual forage legume species namely; woolly pod vetch (*Vicia dasycarpa*), common vetch (*Vicia sativa*), bitter vetch (*Vicia ervilia*), ochrus chickling (*Lathyrus ochrus*), dwarf chickling (*Lathyrus cicera*), and Common chickling (*Lathyrus sativus*). A split-plot experimental design was used in 1989/90 and 1990/91 growing seasons.

In the growth stages trial, forage yield was increased significantly as plants advanced in growth from 10% flowering to full podding time. Narbon vetch produced the highest dry forage yield in 1989/90 season, while common vetch ranked the highest in 1990/91 season.

For all genotypes, As plants growth advanced to full pod formation, digestibility, crude protein ash content and leaves to branches ratio were decreased while crude fiber content was increased. Bitter vetch and common vetch had the highest digestibility levels at the first and second seasons, respectively, while dwarf chickling, common chickling and woolly pod vetch had the highest crude protein content over the two seasons.

Concerning cutting heights trial, generally, 10 cm cutting heights gave better regrowth and produced higher seasonal forage yield, digestible dry matter yield, crude protein yield and ash yield. Over the two seasons, common vetch, dwarf

chickling and common chickling had the highest seasonal forage yield under different cutting height treatments.

الملخص

ان من العوامل الرئيسيه التي يمكن اخذها بعين الاعتبار والتي تعيق نمو الثروه الحيوانيه في الاردن نقص الموارد العلفيه سواء تلك التي تنمو في المراعي الطبيعيه، أو المنتجه كالاعلاف الخضراء، الشعير والنخاله وبعض المركزات. هذا ويستورد الاردن كميات كبيره من الاعلاف من اجل استخدامها في تنمية الثروه الحيوانيه. ففي عام ١٩٨٩ استورد الاردن ٥٤٩ الف طن من حبوب الشعير والذره الصفراء والذره البيضاء ونخالة القمح (دائرة الاحصاءات العامه، ١٩٨٩). ويعود نقص الانتاج من الاعلاف الخضراء بشكل رئيسي الى تناقص المساحات المزروعه بالاعلاف حيث بلغت في عام ١٩٨٨ حوالي ٥٠٠٠ هكتار مقارنه مع اكثر من ٩٠٠٠ هكتار في اواخر الستينات (دائرة الاحصاءات العامه ، ١٩٨٩) . لكن المجال ما زال واسعا لزيادة مساحات الاعلاف عن طريق ادخالها في دورات زراعيه ثنائيه او ثلاثيه مع محاصيل الحبوب الشتويه كالقمح والشعير مما يؤدي الى زيادة الانتاج من الاعلاف بالاضافه الى تحسين خواص التربه الكيمائيه والفيزيائيه . ولقلة المعلومات عن افضل الاصناف والانواع وافضل الطرق لادارة هذه المزروعات ، اجريت هذه الدراسه لتقييم الانتاجيه وبعض صفات الجوده تحت تاثير معاملات مختلفه من الحش لعدد من انواع الاعلاف البقوليه الحوليه وهي :

١ - البيقيا ذات القرون الزغبيه — Vicia dasycarpa
٢ - البيقيا العاديه — Vicia sativa
٣ - الكرسنه — Vicia ervilia
٤ - الفوليه — Vicia narbonensis
٥ - الجلبانه الباميانيه — Lathyrus ochrus
٦ - الجلبانه المتقرمه — Lathyrus cicera
٧ - الجلبانه الشائعه — Lathyrus sativus

تضمنت الدراسه تجربتين استخدم فيهما السبعة انواع السالفة

الذكر في محطه وزارة الزراعه بالمشقر خلال الموسمين الزراعيين ١٩٨٩/١٩٩٠ و١٩٩٠/١٩٩١ . ولقد استخدم تصميم القطع المنشقه لمره واحده وذلك في ثلاث مكررات للموسم الاول واربعه للثاني حيث وزعت السبعه انواع على القطع الرئيسيه بينما وزعت معاملات الحش على القطع الثانويه كالتالي :-

في تجربة مراحل الحش: احتوت القطع الثانويه على ثلاث مراحل للحش وهي ١٠% ازهار و ١٠٠% ازهار ومرحله تكوين القرون التام بينما احتوت القطع الثانويه في تجربه ارتفاعات الحش على ثلاثة ارتفاعات للحش تجرى في مرحله ١٠% ازهار وهي ٥ و ٧,٥ و ١٠ سم فوق سطح الارض ثم تترك النباتات حتى تصل لمرحلة تكوين القرون التام حيث يعاد حشها من على مستوى سطح الارض ولقد كانت مساحة القطع الثانويه ٩مترمربع (٣*٣) لتجربه مراحل الحش و ٧,٥ متر مربع (٣*٢,٥) لتجربه ارتفاعات الحش ويمكن تلخيص النتائج كما يلي :-

١ - ازدادت الماده العلفيه بشكل كبير من مرحلة ١٠% ازهار الى مرحلة تكوين القرون التام حيث وصل الانتاج الى اعلى قيمه له. لذلك فالحش المبكر يعني الحصول على انتاج منخفض من الماده العلفيه.

٢ - تميزت الفويله على جميع الاصناف الاخرى من حيث انتاج الماده الجافه للموسمين. و على كل حال فان الجلبانه المتقزمه والبيقيا الشائعه والبيقيا ذات القرون الزغبيه أعطت انتاج مرتفع في احد الموسمين فقط.

٣ - تناقصت جودة الاعلاف بتاخير موعد الحش، ومع ذلك فان جودة الاعلاف المنخفضه في مرحلة تكوين القرون التام يجب ألا تأخذ كسبب رئيسي لتأييد الحش المبكر.

٤ - تميزت نباتات الجلبانه المتقزمه والجلبانه والشائعه والبيقيا الشائعه والبيقيا ذات القرون الزغبيه بصفات نوعيه جيده.

٥ - حش النباتات ١٠ سم فوق سطح الارض اعطى افضل انتاج موسمي من الماده الجافه واعلى انتاج كلي من الماده الجافه المهضومه والبروتين الخام والرماد.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

APPENDIX A

APPENDIX C

APPENDIX D

INTRODUCTION

In Jordan, red meat production is in shortage. The estimated self sufficiency from locally produced red meat is 24% (MoA, 1989).

The scarcity of feed resources, primarily locally produced forages is the major limitation to animal production. Reliance on the natural rangelands, fallow lands and Field crops residues (straw and stubble) as a primary cheap food source has downgraded the importance of cultivated forages as a basis for more efficient animal production (cattle, sheep and goats).

The potential productivity of dryland farming is low and fluctuates from year to year correlating with seasonal variation in rainfall. This accompanied with deterioration of natural resources such as rangelands due to uncontrolled grazing where no charge to whoever wishes to graze and the expansion of cereal, food legumes and catch-crops on the expense of forage crops will cause the government to depend on imports. In 1989, 549 thousand tones were imported consisting mainly of barley, corn, sorghum and cereal bran (Department of Statistics, 1989).

Rainfed areas comprises about 92% of arable area of approximately 529,000 ha. From this a very small part cultivated by forages every year. In 1988, about 5000 ha were cultivated with forages consisting mainly of bitter vetch and common vetch (Department of Statistics, 1989).

Cereal fallow is a major feature of rainfed agriculture in Jordan, especially in areas with annual rainfall of 200-300 mm (Harvey, 1982). One of the most promising options for increasing forage production is to replace the fallow with pasture or fodder legumes. Such crops provide protein rich food in the form of animal products as well as fixing atmospheric nitrogen for their own needs and contribute to the cereal part. Beside increasing area of forage production, selection of the high yielding forage species adapted to the Jordanian conditions and the proper cultural and management practices should be emphasized in researches. An important research activity is to study the use of forage legumes for feed production. The forages can be used as grazing in spring, made into hay or allowed to mature for seed and straw production. The hay option is attractive since it provides conserved feed for the main deficit period in autumn and winter when ewes are pregnant or lactating. To compete with the other two options, hay making must be an efficient operation producing a high quality product. It is therefore, important to study the effect of crop maturity and cutting height on yield and nutritive value of forage crops conserved for hay.

Therefore, the present study was carried out with the following objectives :

1. Evaluate different forage species and genotypes for the forage yield and quality.
2. Study the effects of growth stages on forage yield and quality.
3. Study the effect of cutting heights on plant regrowth, yield and quality.

2. LITERATURE REVIEW

It is well recognized that the performance of many crops used directly for human consumption can be described by defining the yield and quality of a single harvest taken at a particular stage. By contrast, forage crops may be harvested at different stages depending on the quality of the forage required, and variable number of harvests may be taken during the growing season. Therefore, evaluating the potential forage crops is more complex (Abd El Moneim et al., 1990).

Several studies were conducted involving a compromise between yield and quality of selected forage legume crops as a result of different cutting treatments (cutting stages and cutting frequencies). A summary of the most important findings are presented in this literature review which cover both chickling and vetch crops. The major emphasis will be on forage or herbage production and their chemichal composition.

2.1. Effect of cutting treatments on yield of vetch crops

Gizek and Gikic (1968), in Yugoslavia, found that hay yields of local vetches (Vicia sativa, Vicia villosa and Vicia pannonica) harvested at the beginning of flowering was 43.1% lower than yield at full flowering.

In Cyprus, with an average annual rainfall of 200-387 mm, Hadjichristodoulou (1976) reported that the dry matter yield of common vetch (Vicia sativa) increased with later harvesting. The higher yield was obtained at full pod formation and the lower one was at the beginning of flowering. The dry matter yield increased from the first stage to the second one with 77%.

Similar results were obtained in Pakistan, where common vetch was harvested each 30, 45 and 60 days or at the end of the season under 350 mm of rainfall. The dry matter yields were 417, 1342, 1675 and 2633 kg ha^{-1} for the previous harvesting dates, respectively. So, the final cutting treatment was higher than all other treatments (Abdul Aleem and Noor, 1979).

Trevino et al. (1981) studied the yield and growth of bitter vetch under 420 mm average annual rainfall in a series of trials sown in three successive years. Plants were harvested at seven stages from very early growth to mature pods. The average dry matter yield obtained at 10% bloom, 50% bloom, beginning of pod formation and full pod formation were 4.69, 4.49, 6.16, and 6.2 ton ha^{-1}, respectively. So, the highest yield was produced from cuts taken between the beginning of pod formation and the full pod formation.

The average values of dry forage yield produced at flowering stage were 2.35, 2.27, 2.71 and 1.95 ton ha^{-1} for common vetch, woolly pod vetch, bitter vetch and pea, respectively. An increase in forage yield was detected at pod formation stage. The average values of dry forage yield were 4.02, 3.22, 3.54 and 3.15 ton ha^{-1} for common vetch, woolly pod vetch, bitter vetch and pea, respectively (Ababneh, 1983). From these values we noticed that common and woolly pod vetch are superior to other crops. Similarly, an increase in dry matter yield of common vetch from 1426 kg ha^{-1} at 10% flowering to 3904 and 4460 kg ha^{-1} at 100% pod formation and maturity stage, respectively, was obtained by (Rihawi et al., 1983).

In another study, in U.S.A, Taylor et al. (1984) observed that the vetch entries produced greater dry matter yield under a single-cut system than under multi-cut system.

Droushiotis (1985), in a low rainfall environment of Cyprus, found that the dry matter yields were 2.99, 4.15 and 5.05 ton ha^{-1} when common vetch was harvested at flowering stage, early pod formation and full pod formation, respectively. He predicted an increase in the dry matter yield by 69% when common vetch was harvested at full pod formation compared to early flowering stage.

A comparable results were stated by Sawafta (1985), in Jordan. He reported appreciable increase in the dry matter yield of common vetch, bitter vetch and narbon vetch when harvesting delayed to pod formation stage. The average values of dry forage yield at flowering stage were 0.48, 0.90 and 0.94 ton ha^{-1} while they were 1.08, 1.31 and 1.40 ton ha^{-1} at pod formation stage for the previous crops, respectively.

Moreover, Osman and Nersoyan (1986), in ICARDA, reported that vetch had a higher yield than pea at every seeding ratio in each of the two growth seasons. Vetch gave 3.45 ton ha^{-1} average dry matter yield while pea gave 3.30 ton ha^{-1} when harvested at full flowering stage.

In Jordan, Shorat (1987) stated that seasonal forage yield of medic was greater than common vetch in 1985/86 season; whereas in 1986/87 season, common vetch was superior to medic. Also, he stated that the highest seasonal forage yield was obtained when single cut system was used followed by two-cuts system and finally three-cuts system gave the lowest yield. He also noticed that plants height, number of branches and dry weight per plant were decreased with increasing cutting frequency.

Abd El Moneim and Cocks (1988) studied yield stability of selected forage vetches and found that woolly pod vetch (Accession # 683) yielded the most herbage followed by narbon vetch (Accession # 67) and the lowest was common vetch (Accession # 2541) when harvested at 100% flowering stage. Later on, Abd El Moneim et al. (1990), in Syria, reported that narbon vetch attained the highest dry matter and seed yield in both seasons, and there was very limited variability in the maximum dry matter yield of other entries. In general, the maximum dry matter occurred at 20 to 50% podding in woolly pod vetch; 100% podding in common vetch (Accession # 2541), narbon vetch; and at maturity in common vetch (selection # 2037 and 2020).

Additionally, Ubied (1990), in Jordan, stated that common vetch maintained a high leaves/branches ratio at both flowering and maturity with values of 1.83 and 1.80 at the two growth stages, respectively. So, common vetch produced the greatest leaves production at maturity stage compared to bitter vetch and woolly pod vetch.

2.2. Effect of cutting treatments on yield of chickling crops

Rihawi et al. (1983) reported an increase in the dry matter yield of Lathyrus sativus from 1523 kg ha^{-1} at 10% flowering to 2689 and 3077 kg ha^{-1} at 100% podding and maturity stage, respectively. Similar results were obtained by Trevino et al.

(1984), who studied the yield of Lathyrus sativus under low rainfall conditions in a series of field trials where plants harvested at six stages from very early growth to mature pods. The highest yield were obtained at the beginning of pod or at full pod formation.

Moreover, Thomson et al. (1990) reported that the dry matter of immature herbage and yield of baled and residual hay of chickling were 0.8 and 3.6 ton ha^{-1}, respectively. Also, he obtained 2.5 and 1.7 ton ha^{-1} of straw and seed yield.

In Syria, Abd El Moneim et al. (1990) mentioned that common chickling attained its maximum dry matter yield at 20 to 50% podding stage while ochrus chickling attained it at maturity stage through an evaluation of some annual forage legumes under rainfed conditions.

2.3. Effect of cutting treatments on quality of vetch and chickling crops

Quality has been defined as the amount of nutrient material that the animal can obtain in the shortest time (Walton, 1983). Forage quality (nutritive value) should not be considered as a single parameter, but as composed of a complex of parameters that determine the nutritive intake of the ruminant animals fed on that forage. Thus, the nutritive value of a forage includes beside nutrient concentration the feed intake as an integral component of nutritive value.

Several studies showed that quality of forage crops were influenced by crop species and defoliation practices.

some legume crops at start flowering, 10% flowering, 100% flowering and maturity stage. He found that common vetch gave its maximum yield of digestible dry matter at 100% podding stage. But digestibility percent was decreased from 71% at 10% flowering to 61% at 100% podding stage. The same principle was obtained in Cyprus, by Droushiotis (1985), that the digestible dry matter yield was increased significantly when harvesting was delayed from early flowering to full podding stage. But the average values of digestibility percent of common vetch varieties was decreased from 64.5% at early flowering to 61.4 and 59.9% at early pod formation and full podding, respectively.

Also, Abd El Moneim et al. (1990) obtained a maximum digestible dry matter from all genotypes at 50-100% podding. Narbon vetch had the highest digestible dry matter yield, 5.82 ton ha^{-1}, followed by 4.01 and 3.82 ton/ha for common vetch and woolly pod vetch, respectively, at 50-100% podding stage.

Additionally, the in vitro digestibility of common vetch and narbon vetch decreased from 77.7 and 73.9% at immature stage to 51.4 and 45.5% at mature stage of the previous crops, respectively (Thomson et al., 1990).

Moreover, Ubied (1990) reported that digestibility of leaves was highest with peas and bitter vetch with values around 75%. Also, digestibility of branches was highest with peas and bitter vetch with values around 63% in Jubeiha and 52% in M'shagar location when harvested at flowering stage. At maturity stage, digestibility of common vetch leaves dropped to 55.4% in Jubeiha and to 59.3% in M'shagar.

some legume crops at start flowering, 10% flowering, 100% flowering and maturity stage. He found that common vetch gave its maximum yield of digestible dry matter at 100% podding stage. But digestibility percent was decreased from 71% at 10% flowering to 61% at 100% podding stage. The same principle was obtained in Cyprus, by Droushiotis (1985), that the digestible dry matter yield was increased significantly when harvesting was delayed from early flowering to full podding stage. But the average values of digestibility percent of common vetch varieties was decreased from 64.5% at early flowering to 61.4 and 59.9% at early pod formation and full podding, respectively.

Also, Abd El Moneim et al. (1990) obtained a maximum digestible dry matter from all genotypes at 50-100% podding. Narbon vetch had the highest digestible dry matter yield, 5.82 ton ha^{-1}, followed by 4.01 and 3.82 ton/ha for common vetch and woolly pod vetch, respectively, at 50-100% podding stage.

Additionally, the in vitro digestibility of common vetch and narbon vetch decreased from 77.7 and 73.9% at immature stage to 51.4 and 45.5% at mature stage of the previous crops, respectively (Thomson et al., 1990).

Moreover, Ubied (1990) reported that digestibility of leaves was highest with peas and bitter vetch with values around 75%. Also, digestibility of branches was highest with peas and bitter vetch with values around 63% in Jubeiha and 52% in M'shagar location when harvested at flowering stage. At maturity stage, digestibility of common vetch leaves dropped to 55.4% in Jubeiha and to 59.3% in M'shagar.

2.3.1.2. Chickling crops:

The digestible dry matter yield of common chickling were significantly influenced by maturity stage and rainfall conditions (Trevino et al., 1984). Also, Rihawi et al.(1983) concluded that digestible dry matter production of common chickling peaked at 100% flowering stage, whereas digestibility percent decreased from 74% at 10% flowering to 58% at 100% podding stage.

In Syria, Abd El Moniem et al. (1990) reported that digestible dry matter yield of ochrus chickling and common chickling increased with time. The average digestible dry matter yield of the two species were 2.43 and 2.78 ton/ha, respectively, when harvested at 50% flowering-50% podding stage. This yield increased to 4.64 and 4.31 ton ha^{-1} at maturity stage for the previous two crops, respectively.

In addition to the previous review, Thomson et al. (1990) found that in vitro dry matter digestibility of chickling crops decreased from 78.2% for immature herbage to 47.1% for mature forage (straw) .

2.3.2. Protein content:

Protein is another important constituent of forage quality. The British Agricultural Research Council (1965) considered that all diets for ruminants should contain at least 8.8% crude protein for adequate activity of rumen micro-organisms. So, it is preferable for forage production to have optimum forage yield combined with optimum protein content which is influenced by the species and cutting or grazing practices.

2.3.2.1. **Vetch crops:**

Hadjichristodoulou (1974) reported that crude protein content for common vetch were 24.6, 22.0 and 20.1% at the beginning of flowering, early podding and full podding stage, respectively. Also, in 1976, he found similar trends of protein content for common vetch, woolly pod vetch and pea. The average protein content of the three species were 24.9, 22.3, and 20.6% at the beginning of flowering, beginning of pod formation and at full pod formation, respectively.

Moreover, at early flowering stage, the protein content of common vetch was 25.4% which decreased to 21.9, 21.6 and 19.1% at full flowering, early pod formation and full pod formation, respectively (Trevino and Caballero, 1980).

In 1982, Taylor et al., worked with vetch varieties under different cutting regimes, reported that vetch varieties harvested under the multi-cut system were higher for crude protein percent and yield than varieties harvested under single cut management system (24.5% versus 12.6%).

Ababneh (1983) found that crude protein content of woolly pod vetch, bitter vetch and common vetch harvested at flowering stage were 29.5, 25.7, and 26.8%, respectively. These values decreased at pod formation stage to 25.9, 22.9 and 23.6% for the previous crops, respectively. Also, in 1983, Rihawi et al. reported a reduction in crude protein of common vetch from 20.47% at 10% flowering to 10.05 at 100% pod formation stage. Moreover, Trevino et al. (1981) noticed a reduction in the average of crude protein content of bitter vetch from 18.2% at 10% bloom to 15.7% at full pod formation stage.

In Cyprus, Droushiotis (1985) stated that protein content declined with advanced maturity of common vetch varieties. The average reduction in crude protein content between early flowering and full pod formation was 4.2% units. Crude protein content reached 22.8, 21.6 and 18.6 for early flowering, early podding and full pod formation, respectively.

Shorat (1987) found that protein content was significantly decreased by increasing cutting number. In both locations, the protein content of the three-cut system was greater than those of single and two-cut systems by 4.4 and 2.3 protein units for Jubeiha and by 3.8 and 2.1 for M'shagar location, respectively. The protein content decreased as the plant aged.In Jubeiha, the reduction in protein content was 6.9, 9.4 and 11.4% protein units for three, two, and single-cut system, respectively compared to the first cut of these systems.

Moreover, Thomson et al. (1990) reported that the crude protein content of immature forage of common vetch and narbon vetch were 21.3 and 21.8%.

2.3.2.2. Chickling crops:

Rihawi et al. (1983) reported that Pisum sativum, Medicago regidula and Lathyrus sativus maximized protein production at the 100% flowering stage and thereafter displayed a progressive, and in most cases, very significant reduction towards maturity. Protein production by Lathyrus sativus at maturity was only 49% of the protein yield at 100% flowering stage.

Also, a reduction in crude protein of Lathyrus sativus were significantly influenced by maturity and rainfall conditions

(Trevino et al., 1984).

Moreover, Abd El Moneim et al. (1990) stated that both Lathyrus ochrus and Lathyrus sativus attained maximum crude protein yield at 50-100% podding. At maturity, narbon vetch, common chickling and common vetch (selection # 2541) had the highest crude protein yield in 1986/87 and narbon vetch, common chickling and ochrus chickling in 1987/88. The most of crude protein yield in ochrus chickling was in the pods.

Finally, Thomson et al. (1990) reported a reduction in crude protein content of chickling crop from 22.4% at immature stage to 5.8% at mature stage (straw).

2.3.3. Crude fiber :

Forage quality might be considered, primarily in relation to the fiber content of the forage. So, it is an important parameter that should be determined for different forage species at different cutting systems.

Hadjichristodoulou (1976) stated that the average crude fiber content of common vetch, woolly pod vetch and peas increased from 21.0% at the beginning of flowering to 23.3% at full pod formation stage.

Also, Ababneh (1983) reported that the average crude fiber content of bitter vetch, woolly pod vetch and common vetch at flowering stage were 16.3, 20.5, and 20.39%, respectively. Regarding pod formation stage, the crude fiber content were 19.8, 23.2 and 22.9% of the previous vetch species, respectively. Similar trend was stated by Rihawi et al. (1983) that crude fiber content increased from 20% in young legumes to 40%

at maturity.

In 1985, Hadjipanayiotou et al. reported that crude fiber content (g/kg dry matter) of Cyprus vetch, bitter vetch and common vetch were, for grains; 79, 35 and 52 and for straw; 349, 308, and 351, respectively.

Also, Shorat (1987) pointed out the influence of cutting frequency on crude fiber content of common vetch. A significant differences in fiber content was observed between the three cutting systems in the third cut. In M'shagar, the fiber content of single-cut system was higher than those of two and three-cut system by 4.3 and 8.7% fiber units. Thus fiber content was significantly increased by decreasing cutting frequency. Also, the crude fiber content was increased by aging of the plants.

Moreover, in M'shagar location, Ubied (1990) reported that crude fiber content in leaves of common vetch, woolly pod vetch and bitter vetch at flowering stage were 15.6, 19.7 and 17.3%, respectively. But these values increased to 33.8, 34.2, and 28.4% of branches of the previous crops, respectively.

2.3.4. Ash content:

There is a lack of reports dealing with ash contents as a result of defoliation practices.

In Egypt, Ibrahim et al. (1978) found that ash content on a dry matter basis, ash content decreased with successive cuts.

At ICARDA, Rihawi and Somaroo (1980) stated that young growth was usually high in ash content. As the plant mature, the percentage increased from 14.2% at early bloom to 5.1% at full maturity stage.

Also, Ababneh (1983) indicated that the average ash content of common vetch, woolly pod vetch and bitter vetch decreased from 10.07, 11.52 and 8.02% at flowering stage to 7.98, 8.5 and 6.7% at full pod formation, respectively.

Also, ash content of bitter vetch reduced from 10.0% at 10% bloom to 8.7% at full pod formation stage. Moreover, Thomson et al. (1990) reported that ash content of common vetch, chickling, peas and narbon vetch at immature stage reached 10.0, 8.6, 7.4 and 11.1%, respectively. These values became 10.2, 8.9, 6.3 and 11.1% at maturity stage of the previous crops, respectively.

3. MATERIALS AND METHODS

This study was conducted during two successive growing seasons; 1989/90 and 1990/91 at the Agricultural Research Station, Ministry of Agriculture at M'shagar. M'shagar Research Station is located south of Amman with longitude 35°,48 E; latitude 31°, 34 N and 785 m altitude.

Climate in this area is Mediterranean, and rainfall is usually between October and May. The weather data for both seasons are shown in tables 1 and 2 (Appendix C). The total rainfall in both seasons were almost below average for the site (station) in the period between 1981 and 1990 (347.4).

Rainfall started late in October, with insignificant amount, in both seasons but, the effective rainfall occurred late in January in 1990/91 compared to early December in 1989/90 season.

Both years had some frost days with four days more in 1989/90 season than the second season. Moreover, in 1989/90 season, the temperature dropped down to -1°C after several hot days in April.

The soil at M'shagar characterized by a clayly texture and p^H value around 7.6 (Table 3, Appendix C).

Plant species

Seven annual forage legume species were included for the purpose of this study (Table 1). These crops included four species of vetches; common vetch (Vicia sativa), woolly pod vetch (Vicia dasycarpa), bitter vetch (Vicia ervilia and narbon vetch (Vicia narbonensis) and three chickling species;

Table 1. Species and genotypes of seven annual forage legumes that were included in the experiments during 1989/90 and 1990/91 seasons.

English name	Scientific name	Accession No.	Selection No.
Woolly pod vetch	*Vicia dasycarpa*	683	local
Common vetch	*Vicia sativa*	2541	local
Bitter vetch	*Vicia ervilia*	2542	local
Narbon vetch	*Vicia narbonensis*	67	local
Ochrus chickling	*Lathyrus ochrus*	101	185
Dwarf chickling	*Lathurus cicera*	536	local
Common chickling	*Lathyrus sativus*	347	local

*Source of seeds: ICARDA & NCARTT

common chickling (Lathyrus sativus), ochrus chickling (Lathyrus ochrus) and dwarf chickling (Lathyrus cicera).

Design:

This study was divided into two trials:-

Trial (1): Growth stages trial

This trial involves studying the effect of different growth stages on yield and quality of the seven forage legume crops.

A split-plot design with three replications during 1989/90 season and four replications during 1990/91 season was used for this part. Each replicate comprises the seven pure stands of annual forage legumes as the main plots and three cutting stages as the sub-plot. The cutting was performed at three growth stages as follows;

1. 10% flowering stage
2. 100% flowering stage
3. Full pod formation stage.

These growth stages were determined by a way of counting the proportion of flowered and podded plants in a distance of 50 cm from the four central rows.

Sub-plot size was 3 x 3 meter, consisting of 12 rows 20 cm apart. The alleys between main plots were 0.5 meter and 2 meters wide between replications.

Trial (2): Cutting heights trial

This part involves studying the effect of different cutting heights on regrowth, yield and quality of the seven forage legume crops.

A split-plot design with three replications during 1989/90 and four replications during 1990/91 season was used. The plants were cut when the species reached 10% flowering stage. Three cutting heights were used, there were:

1. 5.0 cm
2. 7.5 cm
3. 10.0 cm

After the first cut, the same quadrate remained until the recovered plants reached full pod formation, then harvested at ground level to determine the most proper stubble height for plant survival and growth recovery after cutting.

Sub-plot size was 2.5 x 3 meter, consisting of 12 rows, 20 cm apart. The alleys between main plots were 0.5 meter and 2.0 meter wide between replicates.

Land preparation and sowing:

In both seasons, the soil was well prepared for the sowing. Diammonium phosphate was hand broadcasted prior to seeding at a rate of 100kg/ha.

Planting was carried out on the 6th and 4th of December for 1989/90 and 1990/91 growing seasons, respectively. Sowing rates were adjusted according to the recommended seeding rates in that region. Narbon vetch and ochrus chickling were sown at the rate of 120 kg/ha while the other four species; woolly pod vetch, common vetch, bitter vetch, common chickling and dwarf chickling were sown at the rate of 100 kg/ha. Seeds were sown by using 6 row planter, 1.5 meter wide.

Chemical weeding by using Fuzilade super against narrow leaf weeds, and for broad leaves, they were hand weeded.

Data collection:

Trial (1):

For each species in the experiment, three harvests were made at three growth stages. For each stage the following data were recorded:

1. Growth and development data:
   a. Number of days to 10% flowering.
   b. Number of days to 100% flowering.
   c. Number of days to full pod formation.
2. Forage yield :

Forage yield was estimated by harvesting an area of $1m^2$ from each sub-plot. The plants were cut at ground level.

Fresh forage yield were measured directly after harvesting by weighing of forage of each quadrate while dry matter yield were measured after drying the harvested forages in forced drought oven at 75°C for 48 hours. Dry samples were grinded and kept for chemical analysis of quality.

3. Plant characteristics:

Fifteen plants were selected randomly from each sub-plot to determine the following characteristics;

a. Plant height (cm); measured at the time of cutting by using 100 ± 0,05 cm ruler.
b. Number of branches per plant.
c. Dry weight per plant (mg), measured after drying at 75°C for 48 hours.
d. Leaves/branches ratio; estimated after separating leaves

from branches of the above ground phytomass and weighing each after drying.

4. Chemical composition:

The grinded dry samples were kept in plastic bags for the proximate analysis as outlined in the official methods of analysis, Association of Official Agricultural Chemists (AOAC, 1970).

a. Crude protein content;

Crude protein in the forage material is determined by analyzing the herbage to find the proportion of nitrogen in the dried sample and multiplying the result by 6.25. Nitrogen determination was done using duplicate samples by Kjeldahl method.

b. Crude fiber content;

In the original method, crude fiber was regarded as the residue after boiling successively with dilute sulfuric acid and sodium hydroxide. For crude fiber determination, duplicate samples of one gram were used.

c. Digestibility;

In vitro digestibility was carried out according Mcleod and Minson (1978) using cellulase enzyme.

d. Ash content;

This fraction includes for the most part the inorganic or mineral components of forage. It is determined by using duplicate samples of 2 grams each for total ash content.

Trial (2):

For each species in this trial, three cutting heights were used at 10% flowering stage. The same quadrates of the recovered plants were harvested secondly at full podding and for each treatment at both harvests, the following data was taken;

1. Forage yield:

Forage yield was estimated by harvesting an area of $1m^2$ from each sub-plot treatment. Dry forage yield was measured after drying for 48 hours in forced drought oven at 75°C while seasonal dry matter yield were measured by summation of the first and second harvest yield.

2. Plant population densities:

Plant population densities were measured at each cut by a way of counting the plants in a distance of 25 cm of each row randomly taken from the four central rows of each plot.

3. Plant characteristics:

Fifteen plants were randomly selected from each sub-plot at the time of the two harvests to measure;

a. Plant height (cm).

b. Number of branches per plant.

c. Dry weight per plant (mg).

4. Chemical composition:

The grinded samples were kept in plastic bags for the proximate analysis as outlined in AOAC (1970). Total digestible dry matter, total crude protein and total ash yield were calculated by as total dry matter yield x % digestibility, % crude protein and % ash, respectively. Crude fiber percent were measured at the two harvests as described in the first trial.

Soil analysis:

Before starting the experiments, soil samples were taken at the depth of 25 cm for some soil physical and chemical properties (Table 3, Appendix C).

Statistical analysis:

Data were statistically analyzed following the general linear models procedure (GLM) of SAS for split-plot design. The treatments mean were compared following the Duncan Multiple Range Test (DMRT), as described by Little and Hills (1978).

4. EXPERIMENTAL RESULTS

4.1. Trial (1) : Growth stages trial

This part of the study was carried out to evaluate seven annual forage legumes (Table 1) as influenced by three cutting stages for both yield and quality components at M'sahgar during 1989/90 and 1990/91 growing seasons.

The results of this part are presented in tables 2 through 10.

4.1.1. Forage yield

Both fresh and dry forage yield of the seven crop species were determined at the three successive stages; 10% flowering, 100% flowering and full pod formation at location during both seasons.

In this part, the dry forage yield results will be presented. However, fresh forage yield results will be shown in table 1 (appendix A).

Differences among genotypes for herbage yield in the first, second and third growth stages were highly significant (Table 2). At 10% flowering, mean dry forage yield of the seven crop species ranged from 68.8 kg/du for ochrus chickling to 110.6 kg/du for narbon vetch and from 40.5 kg/du for common chickling to 109.3 kg/du for dwarf chickling during 1989/90 and 1990/91 seasons, respectively. Over the two seasons, narbon vetch produced the highest dry forage yield, 13% more than the second yielded crop, dwarf chickling, and 73.9% more than the lowest ones, common chickling and bitter vetch.

At 100% flowering, narbon vetch still attained the highest

Table 2. Dry forage yield (kg/du) for seven forage legume crops harvested at three growth stages at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	10F	100F	FPF	10F	100F	FPF
Woolly pod vetch	71.4 a	229.9 b	344.4 b	83.3 abc	146.0 bc	171.8 c
Common vetch	69.8 a	236.7 b	276.1 d	57.5 bcd	137.5 bc	285.8 a
Bitter vetch	70.8 a	222.7 b	283.4 cd	47.3 cd	132.5 bc	199.5 c
Narbon vetch	110.6 a	351.7 a	438.1 a	95.3 ab	193.3 a	240.5 b
Ochrus chickling	68.8 a	129.1 c	237.1 d	72.0 abcd	155.8 abc	270.3 ab
Dwarf chickling	72.9 a	206.7 b	341.1 bc	109.3 a	172.3 ab	255.0 ab
Common chickling	77.9 a	229.8 b	307.4 bc	40.5 d	115.0 c	185.5 c
LSD (0.05)			49.8*			30.2**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between 10F, 100F and FPF for the same crop in 1989/90.

**LSD value to compare between 10F, 100F and FPF for the same crop in 1990/91.

10F = 10% flowering stage.

100F = 100% flowering stage.

FPF = full pod formation stage.

du = dunum (0.1 Ha)

dry forage yield with mean values of 351.7 and 193.3 kg/du for both growing seasons, respectively. Next to narbon vetch were ranked, dwarf chickling, woolly pod vetch, common vetch, bitter vetch, common chickling and ochrus chickling with mean values of 206.7, 172.3; 229.9, 146; 236.7, 137.5; 222.7, 132.5; 229.8, 115; and 129.1, 155.8 kg/du during 1989/90 and 1990/91 seasons for the mentioned crops in the respective order.

At the final harvest, full pod formation stage, the dry forage yield of narbon vetch (438.1 kg/du) was significantly preceded the values of the other crop species in 1989/90, while common vetch attained the maximum dry matter yield, 285.8 kg/du, in 1990/91. Also, there were no significant differences between common vetch, ochrus chickling and dwarf chickling yield at full pod formation in 1990/91 season.

Concerning the forage yield at the three growth stages, one can predict that the dry matter yield increased by aging the plants of the seven species (Figure 1). The dry matter yield increases between 10% flowering and 100% flowering ranged from 102% for ochrus chickling to 201% for bitter vetch. But this increase in dry matter yield between 100% flowering and full pod formation was reduced to 25% for narbon vetch and the maximum increase was 78% for dwarf chickling.

It is worth mentioning that the results obtained revealed a general superiority of the maximum dry forage yield in 1989/90 to 1990/91 season (Figure 1) except for ochrus chickling and common vetch.

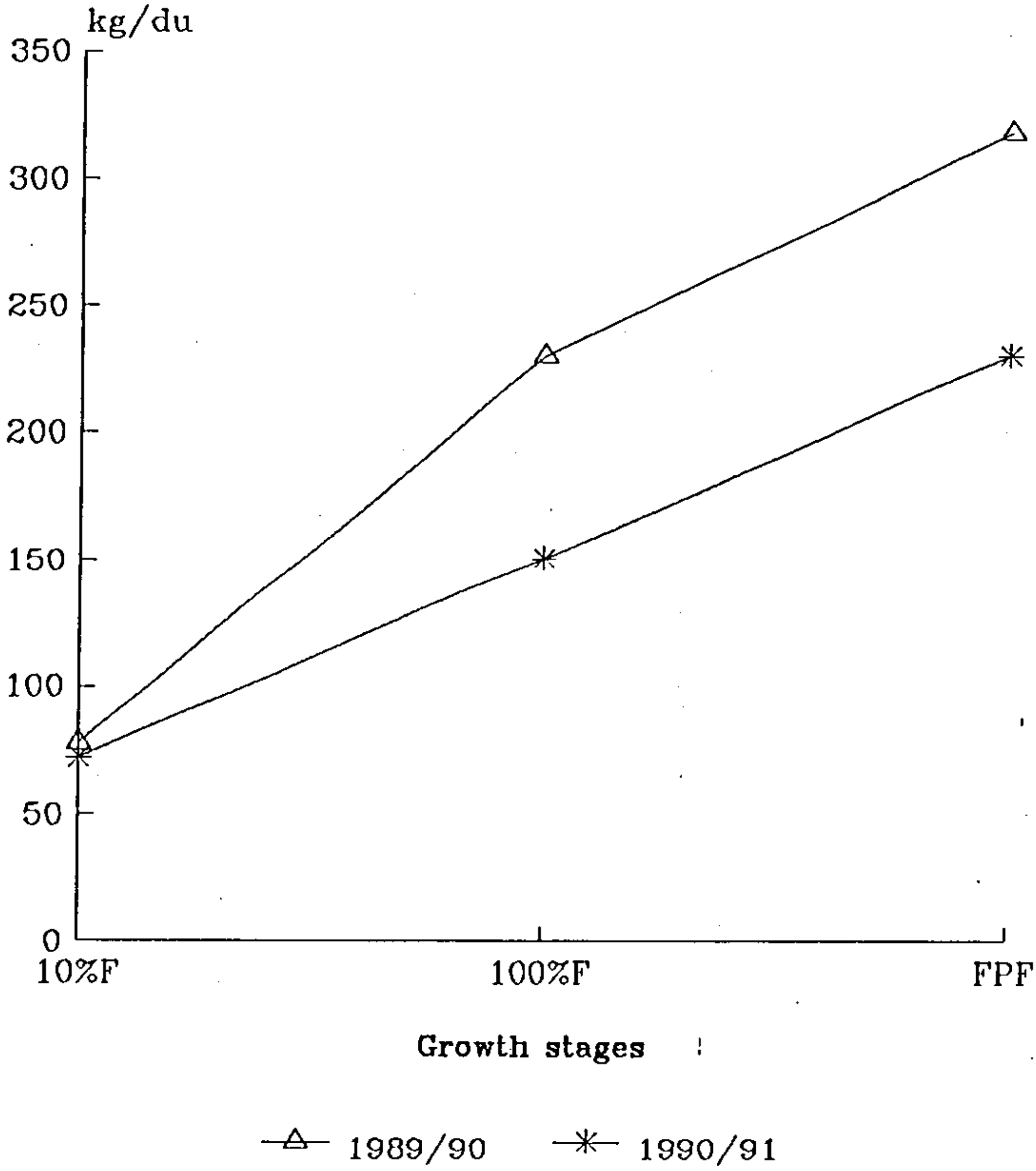

Figure 1 : Average dry forage yield as influenced by three growth stages during 1989/90 & 1990/91 seasons.

4.1.2. Plant characteristics:

This part includes the study of the following traits on individual plant basis (15 plants average); plant weight (mg), plant height (cm), number of branches per plant and leaves/ branches ratio.

4.1.2.1. Plant weight:

A considerable variation among entries during 1989/90 and 1990/91 growing seasons was observed (Table 3). At 10% flowering and 100% flowering stages, narbon vetch has the highest dry plant weight with mean values of 1644.3, 31547 and 1061.3, 2480.3 mg in 1989/90 and 1990/91 seasons, respectively. Moreover, ochrus chickling ranked the second and common vetch was the last.

At the final stage, full pod formation, narbon vetch still has a higher plant weight 4387 mg followed by ochrus chickling which has 41.5% lower dry plant weight and the lowest was bitter vetch (1395 mg) in 1989/90 season. In 1990/91 season, ochrus chickling and narbon vetch has the highest dry plant weights 3106.5 and 3063 mg, respectively while woolly pod vetch was the lowest (917.3 mg).

Statistical analysis indicated that dry plant weight was significantly increased with proceeding plant growth and the highest weight was obtained at full pod formation. The increase in dry plant weight ranged from 60.3% for ochrus chickling to 133.8% for bitter vetch and from 21.3% for dwarf chickling to 82.7% for common vetch from 10% flowering to 100% flowering and from 100% flowering to full pod formation, respectively.

Table 3. Means of dry weight per plant (mg) for seven forage legume crops studied at three growth stages at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	10F	100F	FPF	10F	100F	FPF
Woolly pod vetch	530.7 c	1308.3 d	1747.0 d	575.5 cd	810.3 d	917.3 e
Common vetch	537.3 c	854.3 e	1583.0 d	294.8 e	741.8 d	1332.5 cd
Bitter vetch	600.3 c	1115.3 d	1395.0 e	247.8 e	867.5 d	1185.5 d
Narbon vetch	1644.3 a	3154.7 a	4387.0 a	1061.3 a	2480.3 a	3063.0 a
Ochrus chickling	1161.0 b	1674.0 c	2566.3 b	922.0 ab	1666.0 b	3106.5 a
Dwarf chickling	783.7 c	1922.7 b	2303.7 c	749.5 bc	1237.8 c	1758.8 b
Common chickling	783.0 c	1557.3 c	2707.7 b	467.0 de	1219.0 c	1530.8 bc
LSD (0.05)			224.2*			230.1**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between 10F, 100F and FPF for the same crop in 1989/90.

**LSD value to compare between 10F, 100F and FPF for the same crop in 1990/91.

Also, we can predict a higher plant weight for all species except for ochrus chickling at full pod formation in 1989/90 compared to 1990/91 season.

4.1.2.2. Plant height:

It should be mentioned that plant height was measured by stretchig the plant to its maximum length which does't indicate the canopy height of the plants under field condition, which could be less than that already measured.

Narbon vetch plants were significantly taller than those of all other species (Table 4) at 10% flowering, 100% flowering and full pod formation with mean values of 28.5, 46.1 and 50.92 cm in 1989/90 season, respectively. In 1990/91 season, woolly pod vetch and ochrus chickling have the tallest plants ranging from 22.98 cm at 10 % flowering to 34.85 cm at full pod formation. On the other hand, bitter vetch plants were significantly shorter than any of the other crop entries at the three cutting stages.

There are a significant increase in plant height as the plant aged from 10% flowering to 100% flowering stage for both seasons. Also, a significant increase can be predicted between 100% flowering and full pod formation stages except for bitter vetch and dwarf chickling in both seasons and common vetch and common chickling only in 1989/90 season.

When mean of the species for the two years was considered, we can predict shorter plants in 1990/91 season compared to those in 1989/90 season.

Table 4. Means of plant height (cm) for seven forage legume crops studied at three groth stages at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	10F	100F	FPF	10F	100F	FPF
Woolly pod vetch	25.20 ab	37.59 b	46.43 b	22.98 a	31.18 a	34.85 a
Common vetch	22.19 bc	31.69 c	34.57 cd	16.93 b	22.28 b	24.43 b
Bitter vetch	17.50 d	25.21 d	27.88 e	13.80 c	20.30 bc	21.20 c
Narbon vetch	28.50 a	46.10 a	50.92 a	23.10 a	32.10 a	34.15 a
Ochrus chickling	20.04 cd	31.64 c	36.30 c	24.13 a	32.40 a	34.00 a
Dwarf chickling	16.84 d	26.44 d	30.18 de	17.55 b	22.93 b	24.63 b
Common chickling	17.48 d	29.58 cd	31.42 de	15.53 bc	19.13 c	21.23 c
LSD (0.05)			3.87*			1.95**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between 10F, 100F and FPF for the same crop in 1989/90.

** LSD value to compare between 10F, 100F and FPF for the same crop in 1990/91.

4.1.2.3. Number of branches:

Number of branches per plant was ranged from 2.13 for ochrus chickling to 7.99 for common chickling in 1989/90 and from 1.97 for ochrus chickling to 8.32 for dwarf chickling in 1990/91 season (Table 5).

From these results we can observe that common chickling and dwarf chickling have a significantly higher number of branches than those of other species while Ochrus chickling has the lowest number at the three growth stages for both seasons.

In 1989/90 season, no significant differences were observed between 10% flowering and full pod formation stage, while in 1990/91 season, Number of branches at full pod formation stage was significantly higher than those of 10% flowering and 100% flowering in the respective order.

4.1.2.4. Leaves / branches ratio :

In forage crops, it is useful to calculate the ratio of leaves to branches, which give a preliminary indication a bout the forage quality.

The results in table 6 showed that there is a significant decline in leaves/branches ratio from early flowering to full podding time. The ratio dropped down sharply at full pod formation for ochrus chickling, woolly pod vetch, bitter vetch and common chickling while common vetch and narbon vetch did not.

In both seasons, ochrus chickling maintained the highest ratio at the three cutting stages ranging from 3.8 at 10% flowering to 0.93 at full pod formation and from 2.81 at 10%

Table 5. Means of number of branches per plant for seven forage legume crops studied at three growth stages at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	10F	100F	FPF	10F	100F	FPF
woolly pod vetch	1.85 d	2.48 c	2.67 c	2.55 e	3.11 e	3.50 e
Common vetch	2.81 bc	3.47 b	3.62 b	2.95 d	3.73 d	4.10 d
Bitter vetch	3.42 b	4.07 b	4.37 b	3.82 c	4.31 c	5.11 c
Narbon vetch	2.20 cd	2.34 c	2.53 c	2.34 f	3.11 e	3.30 f
Ochrus chickling	2.13 cd	2.44 c	2.67 c	1.97 g	2.53 f	3.08 g
Dwarf chickling	6.16 a	7.21 a	7.34 a	6.83 a	7.91 a	8.32 a
Common chickling	6.01 a	6.87 a	7.99 a	5.27 b	7.73 b	8.02 b
LSD (0.05)			0.47*			0.02**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between 10F, 100F and FPF for the same crop in 1989/90.

** LSD value to compare between 10F, 100F and FPF for the same crop in 1990/91.

Table 6. Leaves/branches (dry weight) ratio for seven forage legume crops studied at three growth stages at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	10F	100F	FPF	10F	100F	FPF
Woolly pod vetch	2.47 b	2.05 b	1.06 b	1.92 b	1.53 bc	1.10 b
Common vetch	1.86 c	1.83 bc	1.10 b	1.56 d	1.47 c	1.04 bc
Bitter vetch	2.46 b	1.88 bc	1.09 b	1.89 b	1.52 bc	1.03 bc
Narbon vetch	1.45 d	1.25 d	0.93 b	1.49 d	1.33 d	0.89 d
Ochrus chickling	3.80 a	3.11 a	1.86 a	2.81 a	2.46 a	1.85 a
Dwarf chickling	2.34 b	1.99 b	1.14 b	1.81 bc	1.62 b	1.15 b
Common chickling	2.31 b	1.61 c	0.97 b	1.75 c	1.41 cd	0.91 cd
LSD (0.05)			0.18*			0.01**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between 10F, 100F and FPF for the same crop in 1989/90.

** LSD value to compare between 10F, 100F and FPF for the same crop in 1990/91.

flowering to 1.85 at full pod formation during 1989/90 and 1990/91 seasons, respectively. Moreover, narbon vetch gave the lowest value in both seasons. Also, we can see that dwarf chickling, woolly pod vetch and bitter vetch ranked next to ochrus chickling in both seasons.

4.1.3. Forage quality:

The study of forage quality for the different forage crops at three cutting stages includes the determination of digestibility, crude protein, crude fiber and ash content. These parameters will give more information of the comparative advantage of these crops, when they are used as feed at different stages of growth.

4.1.3.1. Digestibility:

Data in table 7 showed that there were no significant differences between all crop species at 10% flowering and 100% flowering stages in 1989/90 season. However, bitter vetch ranked the highest with 69.56 and 65.84% at the two stages, respectively while narbon vetch was the lowest. At full pod formation, there were no greater differences between the seven species. However, bitter vetch and narbon vetch still ranked the highest and the lowest, respectively.

In 1990/91 season, digestibility of forage crops ranged from 71.23% for common vetch to 66.3% for narbon vetch at 10% flowering. However, no significant differences were observed between common vetch, common chickling, woolly pod vetch and dwarf chickling. At 100% flowering, digestibility of forage crops did not differ greatly, even though narbon and bitter

Table 7. Digestibility (%) of seven forage legume crops measured at three growth stages at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	10F	100F	FPF	10F	100F	FPF
Woolly pod vetch	66.85 a	61.94 a	57.46 ab	70.28 ab	65.58 a	60.38 c
Cmmon vetch	67.98 a	63.53 a	59.84 ab	71.23 a	66.38 a	62.15 b
Bitter vetch	69.56 a	65.84 a	62.26 a	68.63 c	63.20 b	61.68 bc
Narbon vetch	66.32 a	61.87 a	56.38 b	66.33 d	62.58 b	58.28 d
Ochrus chickling	68.16 a	62.25 a	58.03 ab	69.18 bc	65.35 a	61.35 bc
Dwarf chickling	67.50 a	64.40 a	58.57 ab	69.80 abc	66.25 a	63.73 a
Common chickling	68.59 a	63.69 a	57.47 ab	70.38 ab	65.83 a	61.18 bc
LSD (0.05)			4.49*			0.23**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between 10F, 100F and FPF for the same crop in 1989/90.

**LSD value to compare between 10F, 100F and FPF for the same crop in 1990/91.

vetch were slightly lower. The values ranged from 66.38% for common vetch to 62.58% for narbon vetch. At full pod formation stage dwarf chickling maintained a higher digestibility, 63.73%, compared to the others, whereas narbon vetch was the lowest.

A significant decrease in digestibility of the seven species was obtained by increasing the age of plants from 10% flowering to full pod formation in both seasons (Figure 2). The average reduction ranged from 11.12 units for common chickling to 7.3 units for bitter vetch in 1989/90 season and from 10.2 units for woolly pod vetch to 6.07 units for dwarf chickling in 1990/91 season.

4.1.3.2. Crude protein content :

Although protein content of dwarf chickling was higher than those of all other species at all cutting stages in both seasons, there were no significant differences between all species at full pod formation stage in 1989/90 (Table 8). In both seasons, crude protein content of dwarf chickling reached 27.54 and 28.63% in the first and second seasons, respectively. On the other hand, bitter vetch and narbon vetch were the lowest at the first two stages, whereas narbon vetch were the lowest at full pod formation in both seasons.

Moreover, a decrease in protein content could be predicted by increasing the plants age (Figure 3). Even though there were no significant differences between 10% flowering and 100% flowering for dwarf chickling, ochrus chickling, bitter vetch and common vetch in 1989/90 season. There were more predictable differences between the two stages in 1990/91 season and a

Table 8. Crude protein content (%) of seven forage legume crops measured at three growth stages at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	10F	100F	FPF	10F	100F	FPF
Woolly pod vetch	24.12 ab	20.20 b	14.29 a	25.35 bc	21.53 b	17.75 c
Common vetc	20.83 b	17.78 b	17.13 a	24.28 cd	18.65 c	17.65 c
Bitter vetch	19.56 b	18.43 b	15.77 a	22.78 ef	21.68 b	18.58 bc
Narbon vetch	23.33 ab	18.66 b	13.84 a	22.20 f	17.60 c	14.30 d
Ochrus chickling	23.56 ab	22.10 ab	16.86 a	23.93 de	21.33 b	17.45 c
Dwarf chickling	27.54 a	25.89 a	17.24 a	28.63 a	23.48 a	20.63 a
Common chickling	25.51 a	21.46 b	17.72 a	26.40 b	22.53 ab	19.63 ab
LSD (0.05)			3.64*			0.10**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between 10F, 100F and FPF for the same crop in 1989/90.

**LSD value to compare between 10F, 100F and FPF for the same crop in 1990/91.

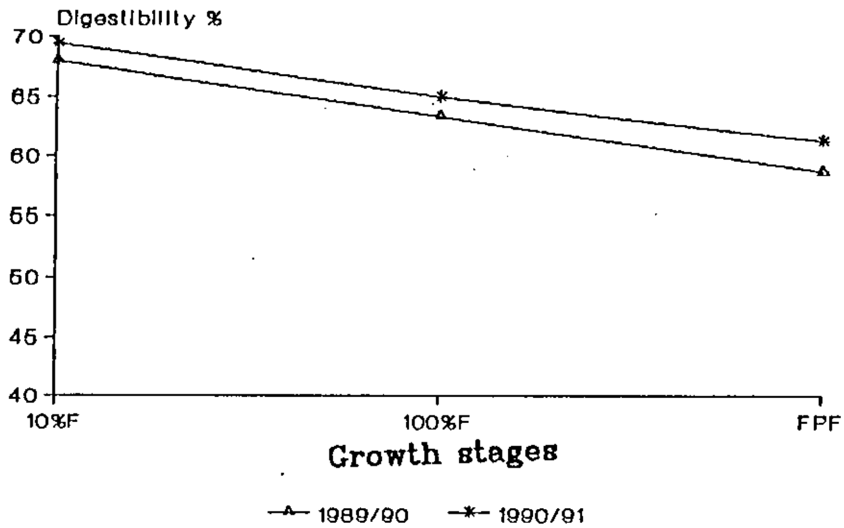

Figure 2: Average digestibility % as influened by three growth stages during 1989/90 & 1990/91 seasons.

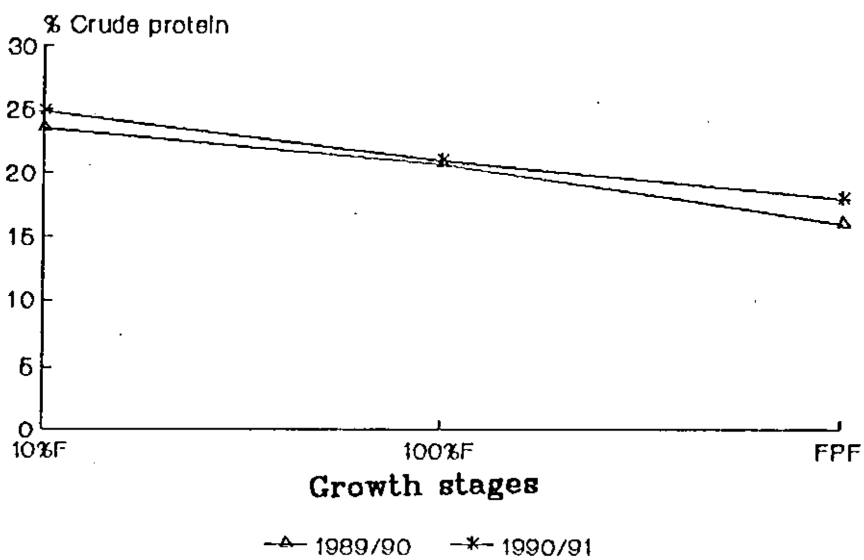

Figure 3: Average crude protein % as influenced by three growth stages during 1989/90 & 1990/91 seasons.

significant interaction between different crop species and cutting stages was predicted also.

4.1.3.3. Crude fiber content:

Narbon vetch was observed to have the highest crude fiber content at all stages and in both seasons (Table 9). The average values ranged from 20.1% at 10% flowering to 26.67% at full pod formation and from 21.05% at 10% flowering to 28.08% at full pod formation in 1989/90 and 1990/91 seasons, respectively. Moreover, woolly pod vetch was proved to be the lowest compared to all other crops at all cutting stages in both seasons. No significant differences were observed between chickling species in both seasons. However, dwarf chickling has lower fiber content than the other two species in 1990/91 season.

The statistical analysis indicates a significant differences between cutting stages. Crude fiber content was increased by increasing plant age (Figure 4). The highest value was obtained at full pod formation stage where the increase in crude fiber content was 6.53 and 7.03 units more than 10% flowering for narbon vetch during 1989/90 and 1990/91 season, respectively. Moreover, the data obtained showed a significant interaction between species and cutting stage in 1989/90 season.

4.1.3.4. Ash content:

Table 10 showed that both narbon vetch and ochrus chickling gave significantly higher ash content than of the other forage species at 10% flowering in both seasons, while at 100% flowering, woolly pod vetch and common vetch attained the highest ash

Table 9. Crude fiber content (%) of seven forage legume crops measured at three growth stages at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	10F	100F	FPF	10F	100F	FPF
Woolly pod vetch	15.77 c	17.68 d	21.71 c	17.28 d	19.23 e	23.38 d
Common vetch	17.22 bc	19.80 c	23.47 b	17.53 d	21.63 d	24.33 c
Bitter vetch	18.92 ab	22.37 ab	24.93 b	19.38 b	23.15 b	25.55 b
Narbon vetch	20.10 a	23.47 a	26.67 a	21.05 a	24.68 a	28.08 a
Ochrus chickling	18.08 b	21.09 bc	24.33 b	17.80 cd	22.58 bc	24.45 c
Dwarf chickling	18.09 b	22.40 ab	24.06 b	17.80 cd	21.40 d	23.53 d
Common chickling	17.27 bc	21.75 ab	23.83 b	18.25 c	22.43 c	23.85 cd
LSD (0.05)			1.68*			0.12**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between 10F, 100F and FPF for the same crop in 1989/90.

**LSD value to compare between 10F, 100F and FPF for the same crop in 1990/91.

content.

At full podding, no significant differences were obtained between narbon vetch, common vetch, woolly pod vetch and ochrus chickling. However, common vetch gave the highest ash content; 10.04 and 9.86% in 1989/90 and 1990/91 seasons, respectively.

Data of the two seasons indicated that there was a consistent trend for the ash content to decrease at the full pod formation stage as compared to that at 100% flowering which is also lower than 10% flowering stage content (Figure 5). The highest reduction occurred in both narbon vetch and common chickling from 14.86 and 13.27% at 10% flowering to 9.08 and 9.91% at full pod formation and from 12.41 and 12.42% at 10% flowering to 6.9 and 7.36 at full pod formation in 1989/90 and 1990/91 seasons, respectively (Table 10).

Table 10. Ash content (%) of seven forage legume crops measured at three growth stages at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	10F	100F	FPF	10F	100F	FPF
Woolly pod vetch	12.96 b	12.31 a	9.82 a	11.86 bc	10.41 abc	9.34 ab
Common vetch	12.21 b	11.17 abc	10.04 a	12.51 ab	11.75 a	9.86 a
Bitter vetch	12.47 b	9.76 cd	7.85 bc	10.62 c	9.44 c	7.64 c
Narbon vetch	14.86 a	9.22 d	9.08 ab	13.27 a	10.26 bc	9.91 a
Ochrus chickling	13.31 b	11.64 ab	10.08 a	12.87 ab	11.32 ab	9.63 ab
Dwarf chickling	12.59 b	10.48 bcd	8.05 bc	11.52 bc	9.33 c	8.43 bc
Common chickling	12.41 b	11.18 abc	6.90 c	12.42 ab	10.90 ab	7.36 c
LSD (0.05)			1.32*			0.05**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between 10F, 100F and FPF for the same crop in 1989/90.

**LSD value to compare between 10F, 100F and FPF for the same crop in 1990/91.

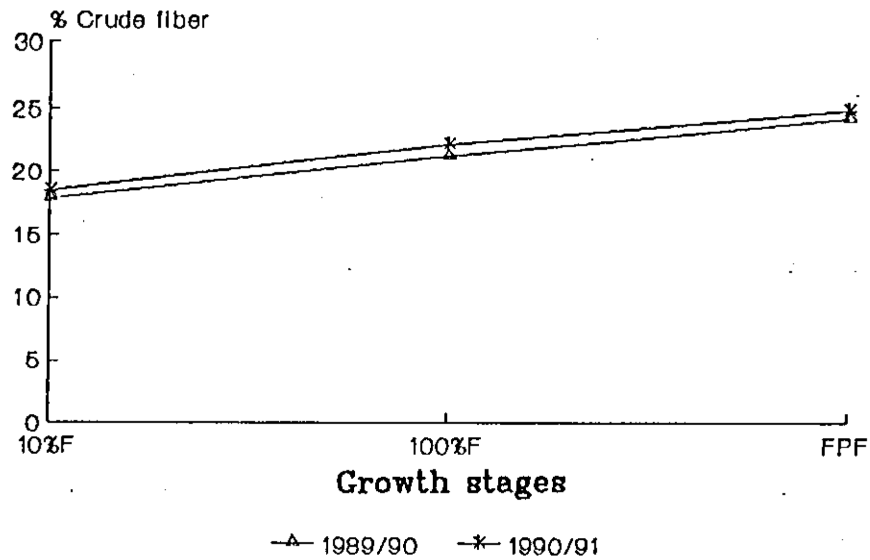

Figure 4 : Average crude fiber % as influenced by 3 growth stages during 1989/90 and 1990/91 seasons.

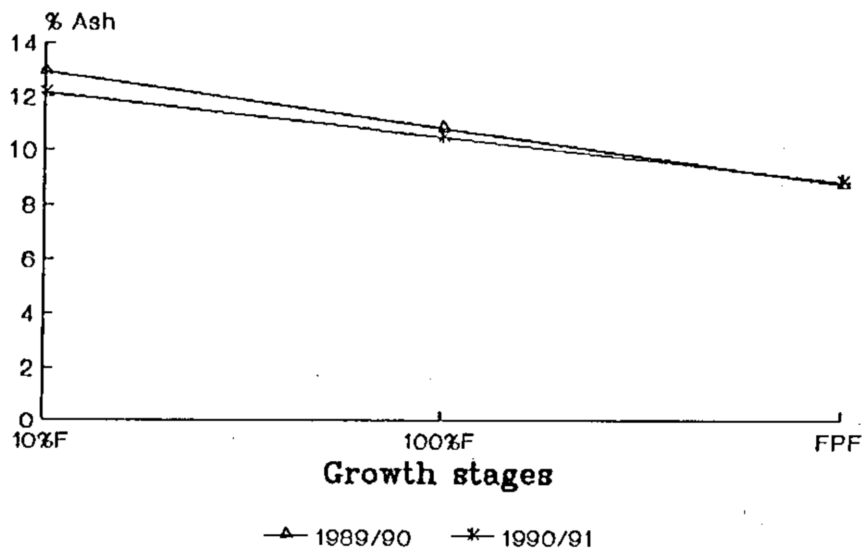

Figure 5 : Average ash % as influenced by three growth stages during 1989/90 & 1990/91 seasons.

4.2. Trial (2): Cutting heights trial

This part of the study was conducted to evaluate t. influence of three cutting heights conducted at 10% flowering stage on crop regrowth, yield and quality of seven crop species grown at M'shagar during 1989/90 and 1990/91 seasons.

4.2.1. Forage yield :

Both fresh and dry forage yield of the seven crop species was determined at the first and second harvests for each cutting height treatment during both seasons. In this part, the dry forage yield results will be presented. Fresh forage yield results are shown in table 2 (Appendix A).

4.2.1.1. Dry forage yield:

Significant differences in dry matter yield between the seven crop species were detected in the first and second harvests (Table 11) .

In the first harvest, at 10% flowering stage, narbon vetch was superior to all other species at all cutting heights. However, a higher dry matter yields were obtained when the plants were cut 5.0 cm above ground level compared to 7.5 and 10 cm.

Although, bitter vetch, narbon vetch and ochrus chickling did not regrow after cutting in 1989/90 season, they resume growth after the first harvest in 1990/91 season (Table 11). Dwarf chickling regrow after cutting at 10% flowering and gave the highest dry matter yield at the second harvest in 1989/90 while common vetch gave the highest quantities in 1990/91 season.

Table 11. Effect of three cutting heights on dry forage yield (kg/du) taken at two harvests of seven forage legume crops at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90 H1	1989/90 H2	1989/90 H3	1990/91 H1	1990/91 H2	1990/91 H3
<u>1-st</u> <u>harvest:</u>						
Woolly pod vetch	65.3 b	57.9 b	50.1 b	54.3 b	50.8 a	46.0 a
Common vetch	61.9 b	55.7 b	47.7 b	33.8 c	29.0 b	24.3 b
Bitter vetch	61.9 b	52.9 b	43.9 b	31.0 c	23.3 bc	21.0 b
Narbon vetch	118.5 a	104.5 a	96.2 a	65.0 ab	56.5 a	48.0 a
Ochrus chickling	61.5 b	54.9 b	45.8 b	61.0 ab	53.0 a	46.0 a
Dwarf chickling	64.7 b	55.3 b	40.2 b	72.5 a	55.5 a	37.8 a
Common chickling	74.4 b	61.4 b	52.0 b	26.8 c	13.0 c	11.3 b
LSD (0.05)			6.3*			6.2**
<u>2-nd</u> <u>harvest:</u>						
Woolly pod vetch	32.4 b	53.6 b	60.1 c	47.5 c	55.0 d	73.5 d
Common vetch	28.6 b	44.9 b	88.2 b	117.0 a	161.3 a	178.5 a
Bitter vetch	----	----	----	61.3 bc	98.0 bc	122.5 c
Narbon vetch	----	----	----	83.5 b	97.3 bc	115.8 c
Ochrus chickling	----	----	----	66.3 bc	76.0 cd	88.3 d
Dwarf chickling	64.0 a	99.8 a	121.6 a	71.0 bc	100.0 bc	146.0 b
Common chickling	34.0 b	59.3 b	73.8 bc	80.5 b	111.3 b	161.0 ab
LSD (0.05)			11.6*			19.5**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between H1, H2, and H3 for the same crop in 1989/90.

**LSD value to compare between H1, H2, and H3 for the same crop in 1990/91.

H1=5.0 cm , H2= 7.5 cm and H3= 10.0 cm cutting heights.

Also, it can be predicted that the dry matter yield of the second harvest for plants harvested firstly at 5.0 cm above ground level was significantly lower than those harvested at 7.5 and 10.0 cm, respectively, in 1989/90 season. Even though, no significant differences between 5.0 and 10.0 cm cutting treatments for woolly pod vetch, common vetch, narbon vetch and ochrus chickling were observed in 1990/91 season.

4.2.1.2. Seasonal forage yield:

The total dry matter yield of dwarf chickling and common vetch was significantly higher than those of other forage crops in both seasons. It was 90.5 and 128.7 kg/du in 1989/90 and 202.8 and 182.8 kg/du in 1990/91 for common vetch and dwarf chickling, respectively. Bitter vetch and ochrus chickling produced the lowest seasonal forage yield in both seasons and woolly pod vetch in 1990/91 season only (Table 12).

Except for bitter vetch, narbon vetch and ochrus chickling in 1989/90, there was a trend to increase seasonal forage yield as the cutting height in the first harvest increased from 5.0 to 10.0 cm (Figure 6). However, no significant differences were observed for seasonal forage yield for most of the crops between 5.0 and 7.5 cm and between 7.5 and 10.0 cm treatments. The average seasonal yields were 95.3, 100.0 and 103.8 kg/du in 1989/90 and 124.5, 140.2 and 160.8 kg/du in 1990/91 for 5.0, 7.5, and 10.0 cm cutting height treatments, respectively. Moreover, interaction between cutting height and crop species was observed in both seasons.

Table 12. Seasonal dry forage yield (kg/du) of seven forage legume crops as influenced by three cutting heights at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	H1	H2	H3	H1	H2	H3
Woolly pod vetch	97.7 ab	111.5 b	110.2 bc	101.8 c	105.8 c	119.5 d
Common vetch	90.5 bc	100.6 b	136.0 b	150.8 a	190.3 a	202.8 a
Bitter vetch	61.9 c	52.9 c	43.9 d	92.3 c	121.3 bc	143.5 bcd
Narbon vetch	118.5 ab	104.5 b	96.2 c	148.5 a	153.8 b	170.5 abc
Ochrus chickling	61.5 c	54.9 c	45.8 d	127.3 abc	129.0 bc	134.3 cd
Dwarf chickling	128.7 a	155.1 a	168.7 a	143.5 ab	157.0 ab	182.8 a
Common chickling	108.4 ab	120.7 b	125.8 bc	107.3 bc	124.3 bc	172.3 ab
LSD (0.05)			10.8*			22.9**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between H1, H2, and H3 for the same crop in 1989/90.

**LSD value to compare between H1, H2, and H3 for the same crop in 1990/91.

4.2.2. Population densities:

A significant differences in population densities were observed between the different species in the first and second cuts. Woolly pod vetch was higher in plant density than all other species while narbon vetch was the lowest (Tables 13 and 14).

Although, no significant differences were found in 1989/90 season between number of regrowing plants harvested firstly at 5.0, 7.5, and 10.0 cm treatments, more predictable differences were observed in the second season (Table 15). However, under all cutting treatments, number of regrowing plants were higher when a stubble of 10.0 cm height was left after the first cut. It can be noticed that there is a considerable decline in plant densities between the first and second harvest in 1989/90 season.

4.2.3. Plant characteristics:

4.2.3.1. Plant weight:

In the first harvest, narbon vetch produced the highest dry plant weight compared to the other species in both seasons (Tables 13 and 14). Woolly pod vetch and common vetch produced significantly lowest plant weight in 1989/90 while in 1990/91, common vetch and bitter vetch produced lowest.

In the second harvest (Table 16), dwarf chickling and common chickling produced highest plant weight in 1989/90 while woolly pod vetch produced lowest in both seasons.

Moreover, dry plant weight increased as the cutting heights above ground level increased from 5.0 to 10.0 cm in the first harvest. However, no significant differences were observed between 5.0 and 7.5 cm treatments on plant weight of common chickling, dwarf chickling, ochrus chickling, common vetch and woolly pod vetch and between 7.5 and 10.0 cm treatments on plant weight of woolly pod vetch, common vetch and dwarf chickling (Table 16).

4.2.3.2. Plant height:

Narbon vetch was significantly taller than all other species in 1989/90 (Table 13). However, in 1990/91, woolly pod vetch, narbon vetch and ochrus chickling were significantly taller than other species in the first harvest (Table 14). On the other hand, bitter vetch was the shortest among other crop entries.

In the second harvest (Table 17), plants harvested firstly 10.0 cm above ground level were significantly taller than those cut at 7.5 and 5.0 cm above ground level in both seasons. In 1989/90, no greater differences were observed between the different species while in 1990/91 season; common vetch, woolly pod vetch and narbon vetch were taller than others under all cutting treatments.

4.2.3.3. Number of branches:

Number of branches of dwarf and common chickling plants were significantly higher than all others followed by bitter vetch in both seasons (Tables 13, 14). The lowest number of branches were observed in woolly pod vetch and ochrus chickling plants at the time of first cut.

Under all cutting heights, dwarf and common chickling has

Table 13. Means of plant height (cm), dry plant weight (mg), number of branches per plant and plants density of seven forage legume crops measured at the time of first harvest at M'shagar during 1989/90 season.

Crop	Plant height (cm)	Plant weight (mg)	Number of branches	Plants density plant/m^2
Woolly pod vetch	25.11 b	533.9 d	1.85 e	255.8 a
Common vetch	22.91 bc	543.1 d	2.81 c	230.8 b
Bitter vetch	17.69 d	603.0 cd	3.44 b	213.0 c
Narbon vetch	28.52 a	1641.8 a	2.21 d	102.5 f
Ochrus chickling	20.84 c	1143.6 b	2.16 de	141.2 d
Dwarf chickling	16.81 d	778.1 c	6.18 a	127.8 e
Common chickling	17.52 d	778.2 c	6.10 a	137.8 d

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

Table 14. Means of plant height (cm), dry plant weight (mg), number of branches per plant and plants density of seven forage legume crops measured at the time of first harvest at M'shagar during 1990/91 season.

Crop	Plant height (cm)	Plant weight (mg)	Number of branches	Plants density plant/m^2
Woolly pod vetch	22.93 a	575.0 cd	2.38 e	249.9 a
Common vetch	16.80 bc	296.3 e	2.86 d	225.2 b
Bitter vetch	13.70 d	256.5 e	3.78 c	206.9 c
Narbon vetch	23.08 a	1031.5 a	2.30 e	100.0 f
Ochrus chickling	22.52 a	904.0 ab	1.92 f	131.9 d
Dwarf chickling	17.58 b	715.3 bc	6.70 a	122.0 e
Common chickling	15.67 c	445.9 de	5.16 b	129.3 de

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

Table 15. Number of regrowing plants per square meter of seven forage legume crops as influenced by three cutting heights, measured at the time of second harvest at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	H1	H2	H3	H1	H2	H3
Woolly pod vetch	137.8 a	153.3 a	191.0 a	241.5 a	245.3 a	248.0 a
Common vetch	69.1 b	127.6 a	131.0 b	221.3 b	223.0 b	225.0 b
Bitter vetch	-----	-----	-----	203.5 c	205.5 c	206.8 c
Narbon vetch	-----	-----	-----	95.8 f	97.8 f	100.3 f
Ochrus chickling	-----	-----	-----	126.3 d	127.8 d	129.3 d
Dwarf chickling	80.8 bc	83.4 b	96.4 bc	117.5 e	119.3 e	120.0 e
Common chickling	52.9 c	60.7 c	86.7 c	125.0 de	127.3 d	129.5 d
LSD (0.05)			36.8*			1.3**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between H1, H2, and H3 for the same crop in 1989/90.
**LSD value to compare between H1, H2, and H3 for the same crop in 1990/91.

Table 16. Means of dry weight per plant of seven forage legume crops as influenced by three cutting heights measured, at the time of second harvest at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	H1	H2	H3	H1	H2	H3
Woolly pod vetch	159.3 b	386.3 c	400.3 c	278.5 c	373.8 c	454.8 d
Common vetch	223.3 b	461.3 c	675.7 b	786.5 ab	984.0 b	1173.0 c
Bitter vetch	-----	-----	-----	589.0 b	804.5 b	1055.3 c
Narbon vetch	-----	-----	-----	927.5 a	1268.0 a	1870.5 a
Ochrus chickling	-----	-----	-----	778.5 ab	977.0 b	1450.0 b
Dwarf chickling	789.0 a	961.7 a	1231.3 a	648.3 b	821.5 b	971.5 c
Common chickling	632.7 a	721.7 b	1215.0 a	743.8 ab	942.8 b	1183.8 c
LSD (0.05)			135.0**			207.6**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between H1, H2, and H3 for the same crop in 1989/90.

**LSD value to compare between H1, H2, and H3 for the same crop in 1990/91.

Table 17. Means of plant height (cm) of seven forage legume crops as influenced by three cutting heights, measured at the time of second harvest at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	H1	H2	H3	H1	H2	H3
Woolly pod vetch	16.0 a	17.0 a	17.5 b	20.0 a	21.5 a	25.1 a
Common vetch	17.4 a	18.5 a	18.9 ab	18.5 ab	20.3 a	22.1 ab
Bitter vetch	----	----	----	15.2 bc	18.1 ab	19.8 bc
Narbon vetch	----	----	----	17.8 abc	20.2 a	22.2 ab
Ochrus chickling	----	----	----	15.7 bc	16.5 b	19.9 bc
Dwarf chickling	16.8 a	18.7 a	21.1 a	14.7 c	16.4 b	18.5 c
Common chickling	17.9 a	21.4 a	21.6 a	17.6 abc	18.7 ab	21.5 bc
LSD (0.05)			0.9*			1.7**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between H1, H2, and H3 for the same crop in 1989/90.

**LSD value to compare between H1, H2, and H3 for the same crop in 1990/91.

Table 18. Means of number of branches per plant of seven forage legume crops as influenced by three cutting heights, measured at the time of second harvest at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	H1	H2	H3	H1	H2	H3
Woolly pod vetch	2.02 b	2.13 b	2.31 b	2.23 cd	2.48 c	2.85 cd
Common vetch	2.22 b	2.36 b	2.40 b	2.73 bc	3.03 bc	3.68 bc
Bitter vetch	----	----	----	3.55 b	3.78 b	4.20 b
Narbon vetch	----	----	----	1.67 b	2.07 c	2.60 d
Ochrus chickling	----	----	----	3.10 bc	3.60 b	3.90 bc
Dwarf chickling	4.23 a	4.46 a	4.16 a	4.73 a	5.25 a	7.03 a
Common chickling	4.06 a	4.15 a	4.61 a	5.13 a	6.13 a	7.15 a
LSD (0.05)			0.13*			0.39**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between H1, H2, and H3 for the same crop in 1989/90.

**LSD value to compare between H1, H2, and H3 for the same crop in 1990/91.

a higher number of branches than other species while common vetch, bitter vetch and ochrus chickling ranked secondly (Table 18). In both seasons, no significant differences were observed between plants of woolly pod, common and bitter vetch cut at 5.0 and 7.5 cm above ground level.

4.2.4. Forage quality:

The results of this part will be presented as total digestible dry matter yield, total crude protein yield, total ash yield, and crude fiber content for both seasons. The measurements of these parameters in term of percentage will be shown in tables 3, 4 and 5 (Appendix A).

4.2.4.1. Total digestible dry matter yield:

No significant differences were detected between the three cutting height treatments in 1989/90 season. However, the total digestible dry matter yield at 7.5 cm treatment were less or slightly higher than that at 10.0 cm treatment (Figure 7). The average total digestible dry matter yield were 63.37, 68.41 and 67.51 kg/du for H1, H2, and H3, respectively (Table 19). Moreover, in 1990/91 season, the highest total digestible dry matter yield were obtained at H3 which were 12 and 24% higher than H2 and H1, respectively.

In 1990/91 season, dwarf chickling produced the highest total digestible dry matter among all other genotypes ranging from 86.11 to 105.89 kg/du for H1 and H2, respectively. At H1 treatment, common vetch, dwarf chickling and narbon vetch produced a higher digestible dry matter than all other entries, while at H2 and H3 treatments, only the common vetch still

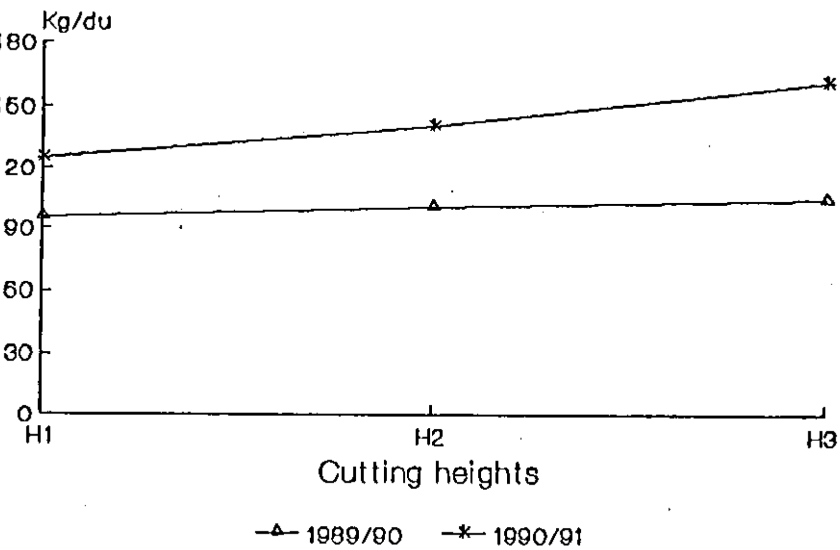

Figure 6 : Seasonal dry matter yield as influenced by three cutting heights during 1989/90 and 1990/91 seasons.

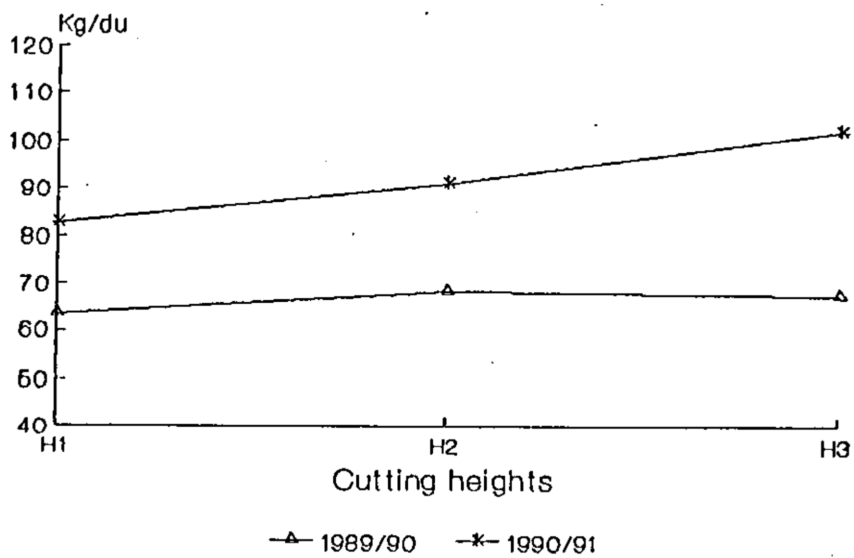

Figure 7: Total digestible dry matter yield as influenced by three cutting heights during 1989/90 and 1990/91 seasons.

Table 19. Total digestible dry matter yield (kg/du) of seven forage legume crops as influenced by three cutting heights at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	H1	H2	H3	H1	H2	H3
Woolly pod vetch	65.98 ab	81.12 ab	71.23 b	69.85 bc	71.77 d	79.94 e
Common vetch	61.61 bc	66.89 b	86.88 ab	101.82 a	123.24 a	128.56 a
Bitter vetch	34.88 d	36.51 c	30.83 c	60.76 c	78.28 cd	89.37 cde
Narbon vetch	78.72 ab	69.76 b	64.17 b	95.47 a	98.07 bc	102.60 bcd
Ochrus chickling	42.05 cd	38.02 c	31.66 c	84.22 ab	84.49 bcd	86.37 de
Dwarf chickling	86.11 a	103.47 a	105.89 a	96.50 a	103.25 b	120.32 ab
Common chickling	74.26 ab	83.11 ab	81.92 b	69.85 bc	74.41 cd	108.80 abc
LSD (0.05)			9.56*			14.11**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between H1, H2, and H3 for the same crop in 1989/90.

**LSD value to compare between H1, H2, and H3 for the same crop in 1990/91.

maintained the highest yield in 1990/91 season. The lowest amount of total digestible dry matter yield were obtained by bitter vetch and ochrus chickling in 1989/90 and woolly pod vetch in 1990/91 season only.

4.2.4.2. Total crude protein yield:

The differences in total crude protein yield of different genotypes at different cutting height treatments followed the same pattern as total digestible dry matter yield (Table 20). With a few exceptions, the different genotypes attained maximum crude protein yield at H3 treatment (Figure 8), even though there were no greater differences between H1, H2 and H3 treatments (Table 20).

In 1989/90 season, dwarf chickling gave the highest total crude protein yield followed by common chickling, narbon vetch, common vetch and woolly pod vetch under all cutting treatments. The crude protein yield of the second season was found to be higher than the first, especially for dwarf chickling and common vetch which attained the maximum yield. As for the total digestible dry matter yield, bitter vetch and ochrus chickling produced the lowest total crude protein yield for both seasons and woolly pod vetch in 1990/91 season only.

4.2.4.3. Crude fiber content:

Fiber content of narbon vetch, in the first harvest was significantly higher than those of all other genotypes at all cutting height treatments (Table 21). On the other hand, woolly pod vetch contained the lowest amount of fiber. Moreover, in the first harvest, we can predict a reduction

Table 20. Total Crude protein yield (kg/du) of seven forage legume crops as influenced by three cutting heights at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90 H1	1989/90 H2	1989/90 H3	1990/91 H1	1990/91 H2	1990/91 H3
Woolly pod vetch	22.40 ab	24.89 b	23.67 b	23.33 cd	23.74 c	26.33 c
Common vetch	18.65 bc	20.21 bc	24.96 b	32.11 ab	38.88 a	40.71 a
Bitter vetch	11.91 c	10.27 d	8.60 c	19.89 d	25.45 c	29.41 bc
Narbon vetch	27.66 ab	24.82 b	23.15 b	30.05 abc	30.50 bc	31.02 bc
Ochrus chickling	13.36 c	12.53 cd	10.71 c	27.37 bcd	27.77 c	28.56 bc
Dwarf chickling	31.09 a	35.63 a	34.64 a	35.53 a	36.98 ab	42.18 a
Common chickling	24.28 ab	26.26 b	28.24 ab	24.72 bcd	26.76 c	35.29 ab
LSD (0.05)			2.36*			4.94**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between H1, H2, and H3 for the same crop in 1989/90.

**LSD value to compare between H1, H2, and H3 for the same crop in 1990/91.

Table 21. Effect of three cutting heights on crude fiber content (%) of seven forage legume crops, measured at two harvests at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90 H1	1989/90 H2	1989/90 H3	1990/91 H1	1990/91 H2	1990/91 H3
1-st harvest:						
Woolly pod vetch	15.77 c	15.58 d	15.35 c	16.48 e	16.23 d	14.98 e
Common vetch	17.22 bc	17.01 cd	16.78 bc	17.43 d	16.78 cd	15.63 d
Bitter vetch	18.92 ab	18.69 ab	18.45 ab	19.68 b	18.33 b	17.88 b
Narbon vetch	20.10 a	19.77 a	19.61 a	21.45 a	20.33 a	19.58 a
Ochrus chickling	18.08 b	17.94 bc	17.71 b	17.23 d	16.28 d	15.93 cd
Dwarf chickling	18.11 b	17.93 bc	17.72 b	18.18 c	17.13 c	16.38 c
Common chickling	17.27 b	17.10 bcd	16.95 bc	17.43 d	16.28 d	16.05 cd
LSD (0.05)			2.15*			0.26**
2-nd harvest:						
Woolly pod vetch	16.58 ab	17.94 ab	18.55 a	17.28 d	18.38 c	19.28 c
Common vetch	16.64 a	16.87 bc	18.37 a	19.20 bc	20.13 b	21.23 b
Bitter vetch	-----	-----	-----	19.58 b	20.13 b	21.32 b
Narbon vetch	-----	-----	-----	23.23 a	24.13 a	25.58 a
Ochrus chickling	-----	-----	-----	18.03 cd	18.50 c	20.28 bc
Dwarf chickling	15.18 b	15.90 c	16.00 b	18.23 bcd	19.52 bc	21.13 b
Common chickling	16.82 a	19.30 a	19.80 a	17.73 d	19.13 bc	20.53 bc
LSD (0.05)			1.69*			0.09**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between H1, H2, and H3 for the same crop in 1989/90.
** LSD value to compare between H1, H2, and H3 for the same crop in 1990/91.

trend in fiber content of the different genotypes as the cutting height increased from 5.0 to 10.0 cm above ground level. However, no greater differences between H1, H2 and H3 were observed.

In general, fiber content increased in the second harvest compared to the first. Moreover, plants harvested firstly at 10.0 cm did not contain a significantly higher fiber content than those cut at 7.5 cm in the first season while in 1990/91 season, the differences were more significant. The lowest fiber content was found in dwarf chickling in 1989/90 and woolly pod vetch and ochrus chickling in 1990/91 season.
Narbon vetch continued to yield the highest crude fiber content in the second harvest also.

4.2.4.4. Total ash yield :

Data in table 22 showed that narbon vetch, common vetch and woolly pod vetch produced the highest total ash yield for both seasons. The highest total ash yield was 19.51 kg/du for common vetch at H3 treatment in 1990/91 season.

On the other hand, bitter vetch has a lower ash yield than other crop entries for both seasons accompanied with woolly pod vetch and common chickling in 1990/91 season.

Also, an increase in the total ash yield, in response to cutting height treatments can be predicted, H3 treatment produced a relatively higher ash yield (Figure 9). However, no significant differences were observed between H1 and H2 and between H2 and H3 treatments for both seasons (Table 22).

Finally, a significant interaction between cutting height and species was observed for total digestible dry matter, crude protein and ash yield and all these measurments followed the same pattern as sesonal dry matter yield (Figures 7,8 and 9).

Table 22. Total ash yield (kg/du/) of seven forage legume crops as influenced by three cutting heights at M'shagar during 1989/90 and 1990/90 seasons.

Crop	1989/90			1990/91		
	H1	H2	H3	H1	H2	H3
Woolly pod vetch	12.19 bc	13.65 a	13.80 a	11.86 bc	12.15 c	13.27 c
Common vetch	10.30 bc	11.74 ab	16.66 a	15.83 a	18.85 a	19.51 a
Bitter vetch	7.69 c	6.60 c	5.52 b	9.35 c	11.66 c	13.32 c
Narbon vetch	17.65 a	15.86 a	14.52 a	17.29 a	17.11 ab	17.39 ab
Ochrus chickling	8.10 c	7.21 bc	6.05 b	14.99 ab	15.07 bc	15.10 bc
Dwarf chickling	14.21 ab	15.37 a	15.86 a	15.26 a	15.65 ab	16.86 ab
Common chickling	12.33 bc	12.94 a	12.11 a	11.61 c	12.11 c	15.14 bc
LSD (0.05)			1.35*			2.04**

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

* LSD value to compare between H1, H2, and H3 for the same crop in 1989/90.

**LSD value to compare between H1, H2, and H3 for the same crop in 1990/91.

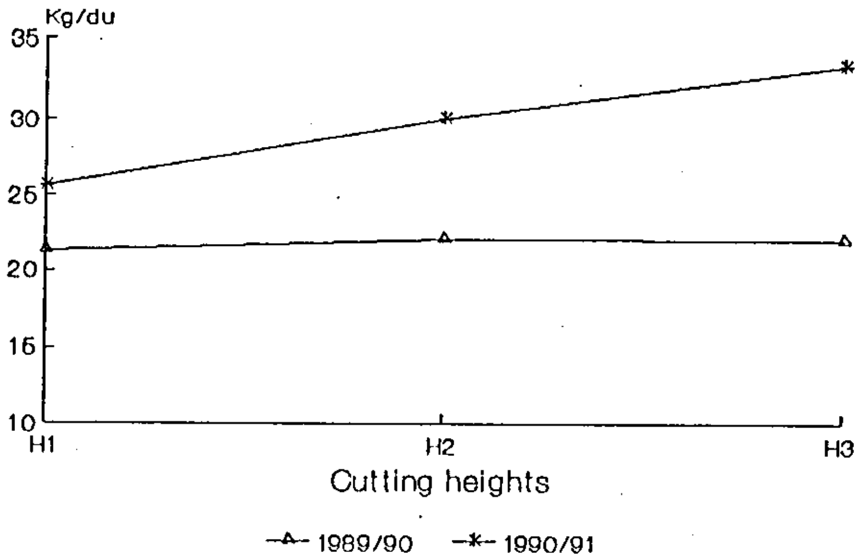

Figure8 : Total crude protein yield as influenced by three cutting heights during 1989/90 and 1990/91 seasons.

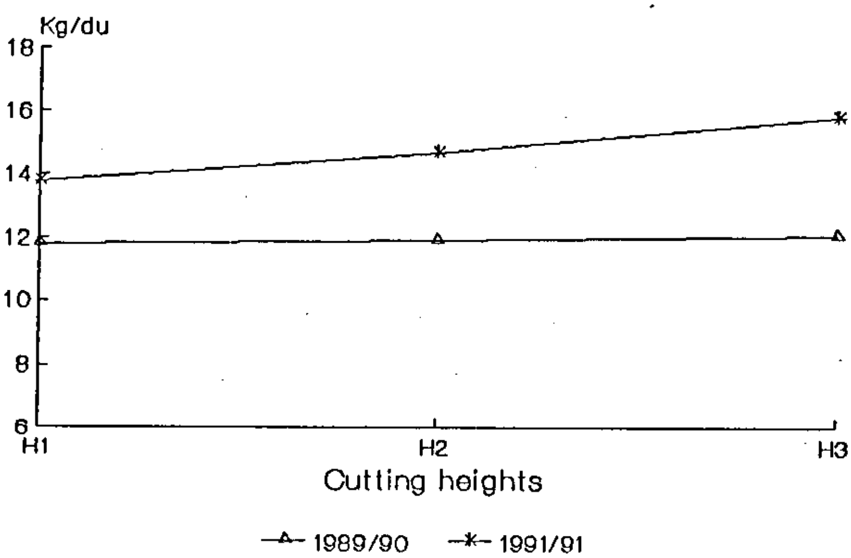

Figure 9 : Total ash yield as influenced by three cutting heights during 1989/90 and 1990/91 seasons.

5. DISCUSSION

Feed shortage is considered an important constraint for livestock production and improvement. In view of the huge diversity of Mediterranean legumes, a few have been used as forages (Abd El Moneim et al., 1990). Kernick (1978) notes that three species of chickling (Lathyrus spp.) and nine of vetch (Vicia spp.) are potentially important, but of these very few have been tested and used. Vetches are indigenous crops extensively utilized in the area long time ago (Abd El Moneim et al., 1990). So the study of productivity and nutritive value of forage legume crops is highly essential under dry land farming in particular. For this purpose, this study was conducted and divided into two trials.

5.1. trial (1): Growth stages trial

There were no greater differences in phenology (Table 1, Appendix B). Ochrus chickling was the earliest to flower. In contrast, woolly pod vetch and dwarf chickling flowered latest. In both season, ochrus chickling was the genotype which reached full pod formation stage earliest while common chickling, woolly pod vetch and dwarf chickling were latest. In 1990/91 season, the effective rainfall started after mid January (Table 2, Appendix C), thus, shortening the life cycle of all species drastically compared to 1989/90 season. In both seasons, common chickling and dwarf chickling remained green for few days more than the other genotypes had matured. Abd El Moneim et al. (1990) stated that this might indicate some sort of drought or heat tolerance.

5.1.1. Forage yield:

Improvement of the production of forage crops can be achieved through selection of high yielding cultivars as well as the adoption of cultural and management practices. In this respect, Decker et al. (1976) stated that the best forage crops is determined by the interaction of species with climate, soil, seeding method and time and forage use. The results shown in table 2 indicate that the amount of forage of all crop genotypes was increased between 10% flowering and full pod formation at which the maximum dry matter yield was obtained. Thus, the forage production of all crop entries can be severely restricted when they are harvested at early growth stages. From this we can predict that forage yield is highly affected by the growth stage at which harvesting is carried out. From the physiological point of view, the dry matter accumulation increases with the advancing stage of maturity (Ababneh, 1983). Similar results were reported (Schmidt, 1962; Wedin, 1962; Hunt and Wagner, 1963; Cannel and Jobson, 1968; Gizek and Gikic, 1969; Hadjichristodoulou, 1976; Habib et al., 1978; ICARDA, 1981; Ababneh, 1983; Droushiotis, 1984 and 1985; and Shorat, 1987).

Also, the present data indicates a general superiority of narbon vetch with respect to dry forage yield over all other crop genotypes for both seasons. however, woolly pod vetch, common chickling and dwarf chickling produced a relatively high forage yield in 1989/90 season. Common vetch and ochrus chickling produced the lowest amount of forage yield in 1989/90 season and this could be attributed to the drop in temperature after unusually hot days during April to -1°C which inversely influenced plant growth and reduced pod setting and development of these species. In 1990/91 season, common vetch, narbon vetch, ochrus chickling and dwarf chickling produced the highest forage yield while bitter vetch, common chickling and woolly pod vetch were the lowest. Observing the results of the two years, we can observe that the dry forage yield of the second season was lower than that of the first with the exception of common vetch and ochrus chickling. This can be attributed to the lower amount of rainfall in 1990/91 season compared to 1989/90 season and also to the shorter growth cycle. Similar fluctuation were reported in forage yield in response to total rainfall for vetches grown in different seasons (Osman and Nersoyan, 1989) or in different locations with different rainfall (Droushiotis, 1985) and in different seasons and locations (Abd El Moneim et al., 1989 and 1990). Also, Trevino and Caballero (1981) found that yield of bitter vetch were strongly influenced by weather conditions, mainly rainfall, and significant variation between years occur. Moreover, he stated that variation in rainfall during the critical 1-2 months before harvesting had a greater effect on dry matter yield than those in total rainfall and consequently, that the distribution of rainfall within a year was a major factor affecting forage yield.

5.1.2. Plant characteristics:

Plant characteristics during the three growth stages is an important indication of crop potential in producing biomass, especially for forage crops used as green forage or cut and processed as hay.

The dry weight of plants is very important parameter, when the forage quantity is considered, because it has a large contribution to forage yield of the different genotypes. Narbon vetch was found to have the highest plant weight over the two years, even though it has the lowest number of branches per plant and this could be explained by having the tallest plants. Also, narbon vetch has a larger leaf area and thicker stems. Although, dwarf and common chickling were shorter than common and woolly pod vetch plants, they have a higher plant weight and it is therefore plausible to attribute this to the higher number of branches per plant of these two species compared to others. Ochrus chickling has a plant weight that ranked next to narbon vetch in 1989/90 season, even though plant height and number of branches do not indicate that, especially at full pod formation stage. This could be explained by that Ochrus chickling has a relatively large leaves and larger pod size. Abd El Moneim et al. (1990) stated that high performance of the crop entries is related to their higher leaf area indices.

Data in table 3 showed that plant weight increased as plant aged and this is an expected result due to the increase in plant height and number of branches per plant and also to the formation of pods and seeds after 100% flowering stage.

Measurements of the ratio of leaves to branches or stems is another important criterion which gives a preliminary indication about the forage quality. As expected, when the ratio is high, the digestibility, protein and ash content of forage will increase and fiber content will decrease.

Results in table 6 showed that, in general, leaves to branches ratio was higher at 10% flowering time as compared to 100% flowering and full pod formation, respectively. At the early stages of growth, the herbage consist mostly of leaves and as plants age, stem or branches start to comprise a greater percentage of the bulk forage.

At 10% flowering, ochrus chickling had a high ratio as compared to other genotypes and maintained a higher ratio at full pod formation which will be reflected positively on forage quality. Leafiness has been found to be the one criterion affecting voluntary intake so far (Minson, 1975 and Hutton, 1975). Leafiness is also correlated positively with protein content (Gupta, 1968) and digestibility (Meyer and Jones, 1962) in different crops. Thus, leafiness appears to be an important morphological attribute which could help in the improvement of nutritive value.

5.1.3. Forage quality :

The efficiency of forage utilization by livestock is dependent upon a large number of factors including quality and quantity of available forage. Forage quality takes into account both nutritive value and rate of consumption (Raymond, 1969). Forage quality, in this study, focused on four quality parameters; digestibility, crude protein, crude fiber and ash contents. The purpose of these measurements is to give more informations of the comparative advantage of these crops when they are used as feed at different growth stages.

The quality of forage is normally dependent on the stage at which it is harvested. Studies of yield and quality in grasses revealed that as plant mature, dry matter increases but forage quality decreases (Corrall, 1979). However, a high forage quality was not only associated with early growth (Cannel and Jobson, 1968) since even within the same canopy the young parts were of higher quality than the more mature lower parts of the plant (Wilkinson et al., 1970).

The significant measure of pasture quality for ruminants according to Raymond (1969) is mainly digestibility which determines the value of feed to the animal. In the present work, digestibility percentage was decreased as plant growth advanced to maturity. Similar trend of results were reported (Taylor et al., 1977; Trevino and Caballero, 1980; Ababneh, 1983; Rihawiet al., 1983; Droushiotis, 1985; Shorat, 1987 and Ubied, 1990).

Genotypic differences in digestibility of forage were also observed (Table 7). Although, there were no greater differe-nces between the different genotypes, in 1989/90 season, bitter vetch has the highest value at the three stages while narbon vetch was the lowest. In 1990/91, woolly pod vetch, common vetch, dwarf chickling and common chickling have a higher digestibility value for both 10% and 100% flowering stages. At full pod formation, dwarf chickling maintained the highest value while narbon vetch was the lowest. In 1985, Droushiotis reported that several varieties of common vetch were differ in their dry matter digestibility. Moreover, the rather lower digestibility value of forage cut at the full pod formation stage should not be used as an argument for advocating early cutting of vetches (Droushiotis, 1985).

The crude protein content is also used to denote the quality of forage for feeding ruminants. Earlier reports indicated that highly productive animals require at least 10% crude protein in their ration (Raymond, 1969). In the present work, the lowest value recorded at full pod formation stage was 13.84% for narbon vetch in 1989/90 season and this is higher than the lowest limit required for highly productive animals. Also, the results in table 8 indicate a general superiority of three chickling species and woolly pod vetch concerning crude protein content over the two seasons. Moreover, crude protein content of all genotypes found to decrease as plants mature. Similar results were found by Hadjichristodoulou (1974) and 1976), Trevino and Caballero (1980), Ababneh (1983), Rihawi et al. (1983) and Droushiotis (1985).

On the contrary, the result of the present investigation showed that crude fiber content increased as the plant approaches full pod formation. This was in agreement with those obtained by Hadjichristodoulou (1976), Rihawi and Somaroo (1980), Ababneh (1983), and Shorat (1987).

Obsourn (1980) stated that the major changes in composition occurring in forage crops are those that accompany maturation. As the plant matures, the proportion of cell walls and its constituent fractions increases and cell content fraction decrease. The proportion of protein and ash content in the dry matter decreases as the plants mature. Hoveland and Monjon (1980) stated that most of forage species decline in nutritive value with age. They referred such decline to the decreasing ratio of leaves to branches combined with increasing lignification of cell walls. They added that stage of growth has a greater influence on nutritive value of forage than any other factor. This factor can be controlled by skillful grazing management and timing of cutting. Schmidt (1962) stated that the reduction in crude protein content as plant matured was due to the loss of lower leaves or deterioration through weathering.

Genotypic differences concerning crude fiber content were observed (Table 9). Narbon vetch has the highest fiber content at the three stages and this might be explained by the lower leaves to branches ratio where branches are thick and more lignified. Moreover, woolly pod vetch maintained the lowest crude fiber content over the three stages in both seasons and dwarf and common chickling in 1990/91 season.

Ash content followed the same pattern as crude protein and digestibility percentage, decreased as plant mature. However no greater differences between species were observed. Although, narbon vetch has the highest ash content at 10% flowering, it can not maintain it up to full pod formation. Common vetch and ochrus chickling for both seasons maintain a higher ash content compared to other species.

5.2. Trial (2) Cutting heights trial

As the young plants continue to grow, it becomes sensitive to enviromental factors, especially day length which causes the production of flowers rather than vegetative buds, in the leaf stem axil. The onset of flowering initiates the release of apical dominance. Commonly a vegetative buds may start to * develop on the lower parts of the shoot or crown that will produce subsequent vegetative growth. the height of cut will consequently determine the number of buds available for regrowth. The height of remaining stubble also determine the stored carbohydrate left behind after cutting. On both accounts a high cut will enhance regrowth (Walton, 1983). One of the essential features of a forage plant is that it should be capable of regrowth if successive defoliation are imposed. Thus, this part was conducted to study the effect of cutting height on plant regrowth and nutritive value.

5.2.1. Forage yield:

Data in table 11 showed that dry matter yield of the first harvest was higher for plants cut at 5 cm above ground level compared to 7.5 and 10.0 cm, respectively. This is due to the fact that by cutting the plants 5.0 cm above ground level, a higher mass of herbage are removed compared to the other two treatments. However, there were no greater differences between the three cutting height treatments.

Regarding the second harvest, we can see the influence of different cutting heights on dry forage yield where 10 cm stubble height produced the highest dry matter yield and this agree with what did Walton (1983) mention firstly.

Concerning the different forage species, we can't observe a greater differences between species at the first harvest. However, narbon vetch was higher than all other species in 1989/90 and dwarf chickling, narbon vetch and ochrus chickling were the highest in 1990/91 season. After the first harvest, narbon vetch, bitter vetch and ochrus chickling did not regrow so that, no forage yield were obtained in 1989/90 season. However, they regrow in 1990/91 season. This failure of regrowth in the first season can be attributed to the drop in temperature to -1°C during April which drastically influenced the remaining stubble height of these crop species which may contain a lower number of buds, especially in the basal leaves stem axil. On the contrary, dwarf chickling, common chickling and common vetch produces the highest dry matter yield at the second harvest, especially when 10 cm stubble height was remained after first cut. This indicates that these species have the ability to be grazed or cut and continue growth after that.

5.2.2. Seasonal forage yield:

With a few exceptions we can observe that as cutting height increased from 5.0 to 10.0 cm, the seasonal dry matter yield were increased. Most of that increase was due to the better regrowth occurred when 10.0 cm stubble height remained after cutting compared to 5.0 and 7.5 cm, respectively.

Also we can predict a genotypic differences according to seasonal forage yield where common vetch and dwarf chickling was significantly higher than those of others for both seasons, followed by common chickling. This indicate a better regrowilng ability of these species, also they can withstand the high temperature and drought conditions prevailing at the end of growing season in such area. Shorat (1987) Found that common vetch can be harvested three times in the season. However, the yield were reduced compared to single cut system.

5.2.3. Population density:

The present work showed that population densities of the different species at the second harvest were drastically reduced in 1989/90 season, especially for those cut at 5.0 cm above ground level. This could be attributed to the adverse climatic condition prevailed after the first harvest during this season. Moreover, non of bitter vetch, narbon vetch and ochrus chickling plants were regrow. However, no such reduction was observed in the second season.

5.2.4. Plant characteristics:

No significant differences for plant characteristics were measured at the time of first harvest between the three cutting height treatments. Thus, the results presented as an average of three plots. However, genotypic differences similar to that present in the first trial (cutting stages trial) at 10% flowering stage were observed.

At the second harvest where the plants were harvested at ground level, differences were observed for plant characteristics between the different treatments. Generally, leaving 10.0 cm stubble height after the first cut enables cut plants to regrow better and produce a taller and heavier plants as compared to 7.5 and 5.0 cm stubble heights. This because in the former, we will remove not only lower ammount of carbohydrate reserve material but also a lower proportion of the photosynthetically active parts of the plant have been removed compared to the latter. So that, plant recovery and regrowth will be faster in the former. On the contrary, no greater differences were observed in the case of number of branches per plant as influenced by cutting heights. However, more predictable differences were observed between different genotypes. Dwarf and common chickling have heavier, taller plants and higher number of branches per plant in 1989/90 while narbon vetch plants was taller and heavier in 1990/91 season.

5.2.5. Forage quality:

From the results obtained, no greater differences were observed between the cutting height treatments concerning total digestible dry matter, crude protein and ash yield. However, with a few exceptions, especially in 1989/90 season, there was a trend to increase all of these parameters as the cutting height increased from 5.0 to 10.0 cm.

Moreover, common vetch, narbon vetch and dwarf chickling have a consistent higher total digestible dry matter, crude protein and ash yield for both seasons. The differences between the different genotypes for these parameters were consistent with their differences in seasonal dry matter yield. On the other hand a general increase in the crude fiber content of different genotypes at the second harvest were detected, and the highest content was for plants cut firstly at 10.0 cm above ground level. The differences between different species followed a similar trend as in the first experiment (cutting stages trial).

SUMMARY

The present study was carried out to evaluate seven annual forage legume species for their dry forage yield, seasonal forage yield, quality and some botanical traits in order to provide farmers with information that assist them to choose the proper crop(s) and stage of growth which will enable them to obtaine maximum dry matter yield accompanied with acceptable feeding value. Moreover, it aims of studying the regrowth capability of the different crop species as affected by three cutting heights conducted at 10% flowering stage.

The annual forage legume genotypes and species included in this study were Woolly pod vetch (Vicia dasycarpa), common vetch (Vicia sativa), bitter vetch (Vicia ervilia), narbon vetch (Vicia narbonensis), ochrus chickling (Lathyrus ochrus), dwarf chickling (Lathyrus cicera) and common chickling(Lathyrus sativus).

For the purpose of this study, two trials were carried out using these seven species under rainfed conditions in Jordan at M'shagar location during 1989/90 and 1990/91 seasons. A split-plot experimental design with three and four replication for the first and second growing season, respectively, was used. Each trial contained the seven crops as the main plot treatments, while the sub-plot treatments were three cutting stages, 10%, 100% flowering and full pod formation, in the first experiment and three cutting heights above ground level, 5.0, 7.5 and 10.0 cm, in the second experiment.

Several botanical and agronomical traits were measured at

the three cutting stages in the first trial and at the first and second harvests in the second trial. Moreover, some quality parameters were measured. The plant characteristics were on 15 plants samples and consisted of; plant weight and height, number of branches per plant and leaves to branches ratio. On per plot basis, days to 10% flowering, 100% flowering and full pod formation, dry forage and seasonal forage yield were measured.

The main result obtained could be summarized as follows:

A. **Trial (1):** Growth stages trial

1. Growth stages has a great influence on dry forage yield. The forage yield increased significantly as the plant advanced in growth. The highest yields were obtained at full pod formation stage, 438.1 and 280.5 kg/du in 1989/90 and 1990/91 seasons, respectively.
2. Generally, narbon vetch was superior in terms of forage yield over all other genotypes. However, in 1989/90, woolly pod vetch, dwarf and common chickling ranked second to narbon vetch in their dry matter yield while in 1990/91, common vetch, ochrus and dwarf chickling were the highest forage producers, especially at full pod formation stage.
3. A considerable variation among crop entries and stages for different characters were detected. The highest plant weight and height and number of branches per plant were obtained at full pod formation stage. Narbon vetch has the heaviest and the tallest plants over all other species followed by ochrus chickling plants, even though they have

the lowest number of branches per plant. On the other hand, dwarf and common chickling has the highest number of branches per plant followed by bitter vetch.

4. The high leaves to branches ratio indicated that the highest leaves proportion of forage masses was at 10% flowering stage which decreased toward plant maturity. The highest value was for ochrus chickling which reached 3.8 at 10% flowering stage, in 1989/90.

5. The quality of forage is normally dependent on the stage at which it is harvested. For all species, digestibility percentage, crude protein and ash content decreased as the plant growth advanced to maturity, while crude fiber content was increased.

6. The results obtained showed that bitter vetch has the highest digestibility level in 1989/90 while in 1990/91, common vetch was the highest. However, there is no great differences between the different species except for narbon vetch which has the lowest digestibility level.

7. Forage quality for forage species indicated that protein content was the highest in dwarf chickling, common chickling and woolly pod vetch over the two seasons.

8. Narbon vetch had the the highest value of crude fiber content at the three growth stages over all other genotypes. Moreover, woolly pod vetch, common and dwarf chickling maintained a lower fiber content than the others.

9. Narbon vetch had the highest ash content at 10% flowering stage in both seasons, however, this content dropd sharply after that stage, meanwhile, common vetch and ochrus

chickling maintain a higher values at 100% flowering and full pod formation.

B. **Trial (2):** Cutting heights trial

1. There were no greater differences in forage yield between the three cutting heights forage yield at the first harvest. At the second harvest, 10.0 cm stubble height gave better regrowth after cutting than 7.5 cm which is better than 5.0 cm. However, there is no significant differences between 5.0 and 10 cm cutting treatments for woolly pod vetch, common vetch, narbon vetch and ochrus chickling were observed in 1990/91, even though a significant differences between treatments was observed in 1989/90.
2. Narbon vetch, bitter vetch and ochrus chickling failed to recover after first cut in 1989/90, however, they continued regrowth in 1990/91 season. Moreover, dwarf chickling common chickling and common vetch had the best regrowing ability in both seasons.
3. Over the two seasons common vetch, dwarf and common chickling had the highest seasonal forage yield, especially at 10.0 cutting height treatment which is higher than the other two treatments.
4. Plant weight and height increased as the cutting height increased from 5.0 to 10.0 cm. Regrowing plants density was greatly influenced by cutting height in 1989/90 while no such influence was observed in 1990/91 seasons.
5. There were no greater differences between cutting height treatments concerning total digestible dry matter, crude

protein and ash yield. However, they tend to increase as cutting height increased from 5 to 10 cm. The differences between crops were consistent with their differences in their seasonal dry matter yield.

CONCLUSIONS

1. There is a clear evidence that forage yield increased greatly from 10% flowering to full pod formation at which maximum forage yield was obtained. Thus, cutting at 10% flowering resulted with low production of dry matter.
2. Narbon vetch was found to be adapted to the conditions of the study as compared to other species, where it produces higher forage yield. However, dwarf chickling, common vetch and woolly pod vetch showed a high yield in one growing season only.
3. Forage quality of all crop entries declined with delayed harvesting, however, the lower nutritive value of forage at full pod formation should not be used to advocate early cutting.
4. Dwarf chickling, common chickling, common vetch and woolly pod vetch have a desirable quality aspects as animal feed.
5. Common vetch, dwarf and common chickling can be cut at 10% flowering stage and still have the capability to regrow if moisture is available, while ochrus chickling, narbon and bitter vetch regrowing ability is questionable and need more investigation.
6. There were no greater differences between different cutting heights concerning forage yield and quality components, however, 10 cm cutting height gave the highest seasonal forage yield and total digestible dry matter, crude protein and ash yield.

7. Although earlier reports indicated lower palatability of woolly pod vetch and narbon vetch compared to other vetch crops, further experimental work is required on such species (Vicia spp. & Lathyrys spp.) to investigate plant-animal interrelations in free choice grazing trials which should be carried out on different locations at different growth stages.

8. In areas where rainfall limits the production of large quantities of forage, priority placed mainly on quantity more than quality. However, a desirable nutritive value with a maximum herbage yield could be obtained when common vetch, dwarf chickling, common chickling, bitter vetch and woolly pod vetch plants were harvested at full pod formation stage.

LITERATURE CITED

1 Ababneh, M. H, Studies on barley-forage legume mixtures under rainfed conditions in Jordan, M. Sc. Thesis, University of Jordan, Amman, Jordan, 1983.

2 Abd El Moneim, A. M., and P. S. Cocks, Yield stability of selected forage vetches (Vicia spp.) under rainfed conditions in West Asia, J. Agric. Sci. Camb, Vol. 111 1988, pp. 295-301.

3 Abd El Moneim, A. M., M. A. Khair, and S. Rihawi. Growth analysis, herbage and seed yield of certain forage legume species under rainfed conditions, J. Agro. and Crop Sci., vol. 164, 1990, pp. 34-41.

4 Abd El Moneim, A. M., A. M. Khair, and S. Rihawi, Effect of genotype and plant maturity on forage quality of certain forage legume species under rainfed conditions, J. Agro. and Crop Sci, Vol. 164, 1990, pp. 85-92.

5 Abdul Aleem and Noor, Effect of harvesting frequency on forage yield, The Pakistan Journal Forestry, Vol.29, No. 3, 1979, pp. 130-140.

6 Association of Official Agricultural Chemists (AOAC) Official methods of analysis, 11-th ed. Washignton, D.C, U.S.A. 1970.

7 Cannell, R. Q., and H. T. Jobson. The relationship digestibility in spring varieties of barley, oat and wheat after ear emergences, J. Agric. Sci. Camb, Vol. 71, 1986, pp. 337-341.

8 Decker, A. M., T. H. Taylor, and C. J. Willard, Establishment

of seedlings. In: Heath, M. E., D. S. Metcalfe, and R. F Barnes, Forages the science of grassland agriculture. The Towa State University Press, Ames, IA, U.S.A., 1976, pp. 384-395.

9 Droushiotis, D. N, The Effect of variety and harvesting stage on forage production of barley in a low rainfall enviroment, J. Agric. Sci. Camb., Vol.102, 1984, pp. 289-293.

10 Droushiotis, D. N, Effect of variety and harvesting stage on forage production of vetch in a low rainfall environment, Field Crop Research, Vol. 10, 1985, pp. 49-55.

11 Gizek, J. and M. Gikic, Influence of varietal characteristics on productivity of winter vetches (Vicia sativa, Vicia villosa and Vicia pannonica), Herb. Abst., Vol. 39, No.2, 1968, pp. 133.

12 Gupta, V. B, Basic concepts in the improvement of pearl millet, Ind. J. Genet., Vol. 28, 1968, pp. 287-294.

13 Habib, M. M., F. H. Khadr, and S. A. El-Sehemy, Production of two alfalfa varieties and three perennial grasses and their mixtures, Alex. J. Agric. Res, Vol. 26, 1978, pp. 633-640.

14 Hadjichristodoulou, A, Forage crop production under rainfed conditions. ALAD, Regional Workshop for Sheep and Forage Production, Beirut, Memeo, 1974, 16p.

15 Hadjichristodoulou, A, Effect of harvesting stage on cereal and legume forage production in low rainfall regions, J. Agr. Sci. Camb, Vol. 86, 1976, pp. 155-161.

16 Hadjipanayiotou, S., S. Economides, and A. Koumas, Chemical composition, digestibility and energy content of legumin-

ous grains and straws grown in Mediterranean region, Ann. Zootech, Vol. 34, No. 1, 1985, pp. 23-30.

17 Harvey, D. R, The production and utilization of forage in the rainfed areas of Jordan, Jordan-Australian Dryland Farming project (unpublished report).

18 Hoveland, C. S., and W. G. Monson, Genetic and enviromental effects on forage quality, In: Hoveland C. S. (ed.), Crop quality, storage and utilization, Amer. Soc. Agron., Crop Sci. Soc. Amer. Mad. WI, U.S.A., 1980, pp. 139-168.

19 Hunt, O. J. and R. E. Wagner, effect of management practices on yield and composition of three grass-legume mixtures, Agron. J, Vol. 55, 1963, pp. 13-16.

20 Hutton, E. M, Improvement of forages for increased animal production. Forage Res, Vol. 1, 1975, pp. 89-97.

21 Ibrahim, S. A., A. K. Abou-Raya, A. M. Makky, and S. El-Samman, The effect of the interseeding Italian ryegrass with clover on the composition, digestibility and feeding value of the green herbage with reference to nitrogen balance, Agric. Res. Rev., Vol. 56, 1978, pp. 135-143, (C. F. Herb. Abst., 52: 112, 1982).

22 International Center for Agricultural Research in the Dry Areas (ICARDA), 1981, Forage improvement program, Project and research highlights.

23 Kernick, M. D, Indigenous arid and semi-arid forage plants of North Africa, the Near and Middle East in ecological management of arid and semi-arid range lands in Africa and the Near and Middle East (EMASAR), Vol. 4, 1978, pp. 519-689, Food and Agricultural Organization.

24 Little, T. M., and F. J. Hills, Agricultural experimentation, design and analysis, John Wiley and Sons, New York, U.S.A., 1978.

25 Mcleod, M. N., and D. J. Minson, The accuracy of pepsin-cellulase technique for estimating the dry matter digestibility in vivo of grasses and legumes, Animal Feed Science and Technology, Vol. 3, 1978, pp. 277-287.

26 Meyer, J. H., and L. C. Jones, Chemical composition and feeding value, Herb. Abst., Vol.32, 1962, p. 300.

27 Minson, D. J, Pasture management and forage nutrition, Forage Res, Vol. 1, 1975, pp. 1-10.

28 Osman, A. E., and N. Nersoyan, Effect of the proportion of species on the yield and quality of forage mixtures, and on the yield of barley in the following year, Exp. Agric, Vol. 22, 1986, pp. 345-351.

29 Raymond, W. F, The Nutritive Value of forage crops, Adv. Agron, Vol. 21, 1969, pp. 1-108.

30 Rihawi, S. and B.H. Somarro, Feed evaluation and utilization, Forage training course, ICARDA, Aleppo, Syria, 1980, pp.73

31 Rihawi, S., P. C. Williams, and B. H. Somaroo, A note of changes in potential nutrition efficiency of different legumes at different stages of maturity. Progress report: clovers and special purpose legumes research, Vol. 16, 1983, pp. 92-95.

32 Santhirasegaram, K., J. E. Coaldrake, and M.H.M. Salih, Yield of mixed subtropical pasture in relation to frequency and height of cutting and leaf area idex, The 10-th International Grassland Congr., Helsinki. (C.F. Herb. Abs., Vol.

36, 1966, 1630).

33 Sawafta, I. A., Production of forage crops, and socio economic factors affecting sheep production under rainfed conditions at Madaba district, M. Sc. Thesis, University of Jordan, Amman, Jordan, 1985.

34 Schmidt, D.R., Dry matter and nitrogen content of oat harvested at various stages, Agron. J., Vol. 54, 1962, pp. 8-10.

35 Shorat. Z. Y., Evaluation of two legume species for forage and animal productivity, M. Sc. thesis. University of Jordan, Ammman, Jordan, 1987.

36 Taylor, A. O., K. A. Hughes, R. M. Haslemore and R. Holand, Influence of maturity and frequency of harvest on the nutritive quality of cool season forage legumes, Proceeding Agronomy Society of New Zealand, Vol. 6, 1977, pp. 49-52.

37 Taylor, R. W., J.L. Griffin and G. A. Meche, Yield and quality characteristics of vetch species for forage and cover crops, Progress Report: clovers and special purpose legume research, Vol. 15, 1982, pp. 53-56.

38 Taylor, R. W., J. L. Griffin, R. P. Mowers, and G. A. Meche, Forage and cover crop characteristics of six vetches. Louisana Agriculture, Vol. 28, No. 1, 1984, pp. 22-23.

39 Thomson, E. F., S. Rihawi, and N. Nersoyan, Nutritive value and yields of some forage legumes and barley harvested as immature herbage, hay and straw in North-West Syria, Exp. Agric., Vol. 26, 1990, pp. 49-56.

40 Trevino, J., R. Caballero, and Y. J. Gill, Estudio comparado de la composition quimico, digestibility y valor energetico

ded anferents cultivares y poblaciones de veza, Pastos, 1980, pp. 140-148. (English summary).

41 Trvino, J. and R. Caballero, Yield and quality of bitter vetch as influenced by harvesting stage and rainfall in semiarid region, Proceedings of the 10-th general meeting of the European Grassland Federation. Riley, H.; Skjelvaag, AAO. (eds), 1981, pp. 417-421.

42 Trevino, J., R. Caballero y C. Centeno, Estudio de los rendimientos y composition quimico bromatologica. de la almorta, cultivada como planta, forrajera de secano en zona semiarida. A.Y.M.A, Vol.25, No. 3, 1984, pp. 461-470. (English summary).

43 Turk, A., Attempts to introduce two years rotation (cereal-forage) integrated with animal production in Jordan, Ministry of Agriculture, Amman (in Arabic).

44 Ubeid, J. S, Comparative study of several legume and cereal yield and quality, M. Sc. Thesis, University of Jordan, Amman, Jordan, 1990.

45 Walton, D. P., Production and Management of cultivated forages, Reston Publishing Company Inc. Riston, Virginia, A Prentice-Hall Company, 1983, pp. 161-167.

46 Wedin, W.F, Yields and percentage of crude protein and moisture of several annual forage crops as affected by harvest date, Agron. J., Vol. 54, 1962, pp. 37-40.

Table 1. Fresh forage yield (kg/du) for seven forage crops harvested at three growth stages at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	10F	100F	FPF	10F	100F	FPF
Woolly pod vetch	507.0 b	1023.2 b	789.0 bc	459.3 b	480.8 b	437.5 d
Common vetch	489.3 b	879.0 b	790.7 bc	276.0 cd	588.3 b	621.5 abc
Bitter vetch	485.0 b	944.4 b	838.9 bc	218.5 d	515.8 b	498.5 cd
Narbon vetch	931.3 a	1687.9 a	1324.5 a	698.0 a	914.0 a	738.8 a
Ochrus chickling	501.7 b	1050.4 b	713.1 bc	398.3 bc	882.0 a	785.8 a
Dwarf chickling	490.2 b	955.4 b	934.7 b	546.0 ab	614.0 b	692.3 ab
Common chickling	514.8 b	1034.9 b	594.4 c	185.8 d	536.0 b	522.3 bcd

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

10F = 10% flowering stage.

100F = 100% flowering stage.

FPF = full pod formation stage.

Table 2. Effect of three cutting heights on fresh forage yield of seven forage legume crops taken at two harvests at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	H1	H2	H3	H1	H2	H3
<u>1-st</u> <u>harvest:</u>						
Woolly pod vetch	466.0 b	411.0 b	362.5 b	361.8 b	339.0 b	286.5 ab
Common vetch	434.1 b	392.0 b	336.5 b	169.3 c	144.3 c	116.5 cd
Bitter vetch	428.6 b	391.6 b	312.3 b	167.8 c	131.8 c	114.5 cd
Narbon vetch	867.3 a	824.4 a	756.2 a	548.0 a	457.5 a	366.8 a
Ochrus chickling	447.6 b	383.9 b	335.4 b	386.0 b	320.5 b	285.8 ab
Dwarf chickling	430.3 b	372.9 b	270.1 b	387.8 b	305.0 b	203.8 bc
Common chickling	477.5 b	402.2 b	353.8 b	145.8 c	88.8 c	73.5 d
<u>2-nd</u> <u>harvest:</u>						
Woolly pod vetch	59.8 b	113.2 b	137.3 b	130.5 c	187.5 c	210.8 c
Common vetch	44.6 b	82.6 b	176.8 b	356.5 a	511.5 a	451.5 a
Bitter vetch	----	----	-----	225.3 bc	359.5 b	408.5 ab
Narbon vetch	----	----	-----	359.0 a	408.8 ab	439.0 a
Ochrus chickling	----	----	-----	291.0 ab	309.0 b	321.8 bc
Dwarf chickling	144.5 a	230.8 a	299.4 a	217.5 bc	374.3 b	420.3 ab
Common chickling	62.3 b	120.2 b	175.2 b	227.5 bc	299.5 bc	423.5 ab

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

H1=5.0 cm, H2= 7.5 cm and H3= 10.0 cm cutting heights.

Table 3. Effect of three cutting heights on digestibility (%) of seven forage legume crops measured at two harvests at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	H1	H2	H3	H1	H2	H3
1-st harvest:						
Woolly pod vetch	66.88 a	67.38 a	68.73 a	71.33 a	71.73 a	72.28 a
Common vetch	67.98 a	68.36 a	68.73 a	71.98 a	72.18 a	73.03 a
Bitter vetch	68.52 a	69.10 a	69.56 a	69.05 b	69.25 b	70.08 b
Narbon vetch	66.34 a	66.52 a	66.73 a	67.08 c	67.43 c	68.38 c
Ochrus chickling	68.16 a	68.59 a	68.88 a	68.25 bc	69.13 b	69.73 bc
Dwarf chickling	67.50 a	68.15 a	68.20 a	68.08 bc	68.48 bc	69.38 bc
Common chickling	68.59 a	69.18 a	68.20 a	67.35 c	67.90 bc	68.83 bc
2-nd harvest:						
Woolly pod vetch	68.82 a	67.31 a	62.33 b	65.33 ab	64.28 ab	63.43 ab
Common vetch	68.70 a	64.27 b	61.24 b	66.23 a	63.45 b	62.13 bcd
Bitter vetch	-----	-----	-----	64.23 b	63.48 b	60.93 de
Narbon vetch	-----	-----	-----	62.13 c	61.68 c	60.33 e
Ochrus chickling	-----	-----	-----	64.28 b	62.88 bc	61.43 cde
Dwarf chickling	66.06 b	65.83 ab	64.49 a	66.38 a	65.23 a	64.28 a
Common chickling	68.12 a	67.19 b	63.05 ab	64.25 b	63.38 b	62.73 bc

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

H1=5.0 cm, H2= 7.5 cm and H3= 10.0 cm cutting heights.

Table 4. Effect of three cutting heights on crude protein content (%) of seven forage legume crops, measured at two harvests at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	H1	H2	H3	H1	H2	H3
1-st harvest:						
Woolly pod vetch	24.12 ab	24.32 ab	24.67 ab	24.78 b	25.23 c	26.13 c
Common vetch	20.83 b	21.16 b	21.52 b	25.15 b	25.68 c	26.43 c
Bitter vetch	19.56 b	19.77 b	20.01 b	22.88 d	23.43 d	23.83 d
Narbon vetch	23.33 ab	23.48 ab	23.69 ab	21.58 e	22.43 e	22.48 e
Ochrus chickling	21.89 b	22.92 ab	23.45 ab	24.00 c	25.03 c	26.30 c
Dwarf chickling	27.54 a	27.75 a	27.13 a	27.33 a	28.20 a	29.43 a
Common chickling	23.84 ab	23.82 ab	24.22 ab	25.40 b	26.68 b	27.83 b
2-nd harvest:						
Woolly pod vetch	20.69 ab	20.39 a	18.86 b	21.85 bc	20.50 bc	19.65 b
Common vetch	19.86 b	18.55 b	16.48 c	20.35 de	19.27 cd	18.48 bc
Bitter vetch	-----	-----	-----	21.38 cd	20.53 bc	19.58 b
Narbon vetch	-----	-----	-----	17.88 ef	16.65 e	15.38 d
Ochrus chickling	-----	-----	-----	19.50 e	18.68 d	18.13 c
Dwarf chickling	20.72 ab	20.34 a	19.59 b	23.40 a	22.13 a	21.30 a
Common chickling	21.12 a	19.78 a	21.06 a	22.90 ab	21.50 ab	19.78 ab

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

H1=5.0 cm, H2= 7.5 cm and H3= 10.0 cm cutting heights.

Table 5. Effect of three cutting heights on ash content (%) of seven forage legume crops, measured at two harvests at M'shagar during 1989/90 and 1990/91 seasons.

Crop	1989/90			1990/91		
	H1	H2	H3	H1	H2	H3
<u>1-st</u> <u>harvest:</u>						
Woolly pod vetch	12.96 b	13.26 b	13.34 ab	11.93 c	12.09 b	12.31 c
Common vetch	12.21 b	12.50 b	12.90 b	12.61 b	13.21 a	13.43 ab
Bitter vetch	12.47 b	12.56 b	12.69 b	10.73 d	10.90 c	11.41 d
Narbon vetch	14.86 a	15.02 a	14.84 a	13.52 a	13.71 a	14.06 a
Ochrus chickling	13.31 b	13.39 b	13.43 ab	12.39 bc	13.11 a	13.61 a
Dwarf chickling	12.60 b	12.69 b	12.60 b	11.81 c	12.12 b	12.82 bc
Common chickling	12.14 b	12.25 b	12.13 b	12.42 bc	13.21 a	13.54 a
<u>2-nd</u> <u>harvest:</u>						
Woolly pod vetch	11.39 a	11.10 a	11.84 a	11.21 a	10.87 a	10.31 a
Common vetch	9.56 a	10.58 ab	11.86 a	9.87 b	9.32 b	9.11 c
Bitter vetch	-----	-----	-----	9.82 b	9.32 b	8.91 cd
Narbon vetch	-----	-----	-----	10.18 b	9.63 b	9.21 bc
Ochrus chickling	-----	-----	-----	11.21 a	10.65 a	9.96 ab
Dwarf chickling	9.37 a	8.33 b	8.70 b	9.42 b	8.91 b	8.22 d
Common chickling	9.80 a	9.18 ab	7.90 b	10.22 b	9.31 b	8.43 cd

Means within a column followed by the same letter do not differ significantly at the 5% level of probability according to Duncan Multiple Range Test (DMRT).

H1=5.0 cm, H2= 7.5 cm and H3= 10.0 cm cutting heights.

Table 1. Number of days to 10%, 100% flowering and full pod formation stages of seven forage legume crops included in the study during 1989/90 and 1990/91 growing seasons.

Crop	1989/90			1990/91		
	10F	100F	FPF	10F	100F	FPF
Woolly pod vetch	106	111	133	62	79	92
Common vetch	101	106	125	52	69	88
Bitter vetch	92	109	123	52	69	83
Narbon vetch	94	106	123	56	70	82
Ochrus chickling	87	99	116	48	60	79
Dwarf chickling	106	111	136	66	80	93
Common chickling	92	109	131	49	71	90

10F = 10% flowering stage.

100F = 100% flowering stage.

FPF = full pod formation stage.

Table 1. Amount of rainfall and temperature data reading at M'shagar location during 1989/90 season.

Month	Rainfall (mm)	Mean air temp. °C	Mean Temp. °C Min.	Mean Temp. °C Max.	Min. Temp. °C	Max. Temp. °C	# of days < 0°C
October	4.0	17.7	12.0	23.3	7.0	33.0	0
November	6.8	14.0	8.8	19.9	4.0	26.0	0
December	30.0	8.8	5.2	14.4	-3.0	21.0	4
January	95.1	8.5	2.5	9.9	-4.0	16.0	9
February	77.9	6.8	2.3	11.2	-2.0	18.0	6
March	48.5	9.6	4.1	15.7	0.0	19.0	3
April	51.7	13.7	8.9	20.6	-1.0	30.0	2

Total = 314 mm

Mean of 1981-90 = 347.4 mm

Table 2. Amount of rainfall and temperature data reading at M'shagar location during 1990/91 season.

Month	Rainfall (mm)	Mean air temp. °C	Mean Temp. °C Min.	Max.	Min. Temp. °C	Max. Temp. °C	# of days < 0 °C
October	4.2	19.6	13.0	26.2	6.0	34.0	0
November	6.0	16.1	10.1	22.2	3.0	29.0	0
December	2.0	11.5	5.2	17.8	-3.0	27.0	4
January	75.7	6.9	1.5	12.4	-4.0	15.0	9
February	74.7	8.0	2.3	13.8	-1.0	23.3	5
March	110.4	12.5	6.7	18.4	0.0	26.0	2
April	3.5	17.1	9.3	24.8	3.0	32.0	0

Total = 279.0 mm

Mean of 1981-90 = 347.4 mm

Table 3. Some soil properties of M'shagar location.

Characters (0-25) cm depth	Value
% silt	25.90
% sand	6.20
% clay	67.90
Texture	clay
% Organic matter	0.50
Electrical conductivity (mmhos/cm)	0.17
p^H	7.60
P (ppm)	113.40
K (ppm)	275.70

Table 1. Mean squares for several characters of seven forage legume crops harvested at three growth stages during 1989/90 season.

Source of variation	df	Fresh yield kg/du	dry matter yield kg/du	leaves/ branches ratio	No. of branches per plant	Plant height cm	Plant weight mg	Crude protein %	Crude fibe %	Ash %	Digestibility %
Blocks	2	51863.12	3126.652	0.02361	0.14146	20.0596	66268.59	1.62471	0.23536	6.71052	19.4629
A treat.	6	413828.3**	19438.59**	2.50894**	38.4972**	403.125**	4548418**	36.3437*	22.1055**	4.56014*	17.5274
Error a	12	26155.67	1460.338	0.06716	0.47993	9.58284	26729.8	8.48865	1.00365	1.16802	12.4729
B tret.	2	1275181.3**	311379.7**	8.06115**	4.84163**	1388.46**	12156366**	290.219**	203.393**	88.3801**	449.7017**
A * B	12	26868.82	3340.262**	0.18012**	0.25261**	18.0397**	366380.9**	8.07536	0.81605	3.1366**	1.8007
Error b	28	18074.45	888.256	0.01081	0.07871	5.3666	17976.06	4.73175	1.0111	0.61875	7.38974

* = P≤ 0.05 ** = P≤ 0.001

Table 2. Mean squares for several characters of seven forage legume crops harvested at three growth stages during 1990/91 season.

Source of variation	df	Fresh yield kg/du	dry matter yield kg/du	leaves/ branches ratio	No. of branches per plant	Plant height cm	Plant weight mg	Crude protein %	Crude fibe %	Ash %	Digestibility %
Blocks	3	58697.84	1428.365	0.002	0.003	10.998	98339.51	0.329	0.11	0.314	0.324
A treat.	6	254373.8**	8050.234**	1.708**	51.281**	346.097**	4039447**	46.486**	26.617**	7.995*	25.251**
Error a	18	20908.25	1166.985	0.02422	0.02338	7.811	45120.48	2.404	0.531	2.244	2.431
B tret.	2	515080.2**	173883.7**	4.038**	14.045**	571.604**	10541092**	325.04**	279.506**	74.892**	466.215**
A * B	12	39545.85**	2554.073**	0.029**	0.725**	9.82**	509204.3**	3.356**	1.304**	1.527**	2.63**
Error b	42	9899.13	448.849	0.000476	0.000119	1.852	25986.77	0.0054	0.00648	0.00124	0.025

* = $P \leq 0.05$ ** = $P \leq 0.001$

Table 3. Mean squares for several characters of seven forage legume crops harvested at three cutting heights at 10% flowering during 1989/90 season.

Source of variation	df	dry matter kg/du	No. of branches per plant	Plant height cm	Plant weight mg	Plant density Pl./m²	Crude protein %	Crude fiber %	Ash %	Digestibility %
Blocks	2	255.6211	0.175525	8.52614	16495.19	153.696	53.17	6.2069	20.3559	42.583
Treat a	6	3370.194**	30.8983**	175.3744**	1466683.9**	31600.167**	54.3716	16.491**	7.518533*	6.96119
Error a	12	561.5756	0.11626	6.5513	34262.36	81.13146	18.7447	2.509	1.96595	18.7209
B tret.	2	1871.613**	0.028673	0.28743	561.333	9.2576	1.37491**	0.9052**	0.23243**	.602692
A * B	12	16.2553	0.009977	3.00727	223.944	36.9217	0.29731*	0.004457	0.057952*	0.45488
Error b	28	14.224	0.026373	1.49212	352.2619	19.69254	0.11869	0.005576	0.0204659	1.65545

* = $P \leq 0.05$ ** = $P \leq 0.001$

Table 4. Mean squares for several characters of seven forage legume crops harvested at ground level at full pod formation during 1989/90 season.

Source of variation	df	dry matter kg/du	No. of branches per plant	Plant height cm	Plant weight mg	Plant density $Pl./m^2$	Crude protein %	Crude fiber %	Ash %	Digestibility %
Blocks	2	516.797	0.031	16.30	8800.778	943.255	0.052	2.111	4.813	2.971
Treat a	3	4117.6**	12.509**	15.359	934496.4**	15081.29**	9.565**	13.583**	14.932	4.025
Error a	6	293.505	0.364	9.336	13305.93	359.264	0.388	0.87	3.485	0.909
B tret.	2	6401.23**	0.169**	23.197**	411831.7**	481.75	7.701**	9.958**	0.297	82.053**
A * B	6	274.951**	0.083**	1.780**	80322.4**	1340.927*	2.206**	1.314*	2.585**	6.270**
Error b	16	45.161	0.006	0.2522	7820.472	452.808	0.113	0.444	0.236	0.951

* = P≤ 0.05 ** = P≤ 0.001

Table 5. Mean squares for several characters of seven forage legume crops harvested at three cutting heights at 10% flowering during 1990/91 season.

Source of variation	df	dry matter kg/du	No. of branches per plant	Plant height cm	Plant weight mg	Plant density Pl./m^2	Crude protein %	Crude fibe %	Ash %	Digestibility %
Blocks	3	175.254	0.166	3.655	76797.345	121.29	0.083	0.077	0.066	0.381
Treat a	6	3311.68**	37.312**	209.69**	1052792.1**	41784.71**	49.355**	30.515**	9.728**	40.312**
Error a	18	180.208	0.029	4.975	64289.271	84.56	0.0571	0.561	0.564	2.302
B tret.	2	1741.54**	0.003	0.009	264.905**	2.869	18.243**	18.851**	4.761**	10.833**
A * B	12	89.619**	0.004**	0.011	11.391	6.105	0.478**	0.231**	0.134**	0.085**
Error b	42	18.655	0.0034	0.013	14.020	6.500	0.003	0.0034	0.001	0.033

* = P≤ 0.05 ** = P≤ 0.001

Table 6. Mean squares for several characters of seven forage legume crops harvested at ground level at full pod formation during 1990/91 season.

Source of variation	df	dry matter kg/du	No. of branches per plant	Plant height cm	Plant weight mg	Plant density Pl./m^2	Crude protein %	Crude fibe %	Ash %	Digestibility %
Blocks	3	948.30	0.734	14.159	67567.25	234.044	0.297	0.359	0.055	0.348
Treat a	6	10709.2**	27.892**	46.676**	1082770.8**	41575.94**	42.063**	47.041**	6.183**	18.813**
Error a	18	341.75	1.266	11.204	47022.43	78.497	2.324	2.289	0.701	2.29
B tret.	2	18423.0**	10.032**	126.969**	1672882.1**	116.143**	32.086**	37.282**	8.658**	44.147**
A * B	12	676.12**	0.553**	0.941	68670.52**	1.657	0.344**	0.262**	0.135*	1.226**
Error b	42	185.38	0.075	1.341	21099.69	1.504	0.004	0.002	0.06	0.0043

* = $P \leq 0.05$ ** = $P \leq 0.001$

Table 8. Mean squares for several characters of seven forage legume crops as influenced by three cutting heights during 1990/ 91 season.

Source of variation	df	Seasonal dry matter yield kg/du	Total crude protein yield kg/du	Total ash yield kg/du	Total dig. dry matter yield kg/du
Blocks	3	1807.81	60.069	21.585	746.097
Treat a	6	7920.71**	363.33**	76.615**	3190.91**
Error a	18	754.624	48.01	9.385	304.923
B tret.	2	9290.58*	236.17**	29.748**	2714.94**
A * B	12	560.333*	20.807	3.540**	223.726*
Error b	42	257.829	11.977	2.458	97. 735

* = P≤ 0.05 ** = P≤ 0.001

Table 7. Mean squares for several characters of seven forage legume crops as influenced by three cutting heights during 1989/90 season.

Source of variation	df	Seasonal dry matter yield kg/du	Total crude protein yield kg/du	Total ash yield kg/du	Total dig. dry matter yield kg/du
Blocks	2	713.084	52.18	20.854	404.547
Treat a	6	11111.7**	606.332*	121.99*	4789.69**
Error a	12	841.091	64.814	18.808	375.625
B tret.	2	378.684**	3.526	0.457	151.609*
A * B	12	631.892**	15.27*	8.682*	207.784**
Error b	28	41.881	1.986	0.648	32.646

* = P≤ 0.05 ** = P≤ 0.001