RESPONSE OF SOME NARBON VETCH VARIETIES TO DIFFERENT DEFOLIATION INTENSITIES CONCERNING FORAGE, SEED YIELD AND GROWTH TRAITS UNDER RAINFED CONDITIONS OF THE SULAIMANI GOVERNORATE, IRAQ

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Abstract. To study the response of some narbon vetch varieties to different defoliation intensities on forage, seed yield and their components under rain fed condition. A field experiment was conducted at College of Agricultural Sciences-University of Sulaimani in Iraq country during the winter season of 2017-2018, using split plot design. Three varieties of narbon vetch (ICARDA 2561, ICARDA 2380 and ICARDA 2706) were implemented in the main plots and arranged according to Randomized Complete Block Design and replicated three times, and four defoliation intensities (different height of forage cutting from ground level) Control (not defoliated), Low = 8 cm, Moderate = 6 cm and Severe = 4 cm from ground level) were allotted in subplots. Means comparisons were carried out using the least significant difference test (LSD) at 5% and 1% significant levels. The results of this study indicated that the interaction between ICARDA 2561 and moderate defoliation intensity gave the highest values of fresh forage yield and fresh stem percent, and the interaction between ICARDA 2380 and severe defoliation intensity gave maximum fresh leaf percent, Regarding leaves/stem ratio, maximum ratio showed by interaction between ICARDA 2561 and low defoliation intensity. The interaction between ICARDA 2380 and moderate defoliation intensity awarded the highest values of most traits such as plant height, no. of branches/plant, no. of leaves/plant, leaves weight/plant, leaves dry weight/plant and stem dry weight/plant, Maximum values of these traits biological yield, pods number/m², pod yield, seed number/pod and seed yield reached attained by the interaction between ICARDA 2706 and control treatment, but the interaction between ICARDA 2561 and control treatment gave the highest values of pod length and seeds weight/pod but concerning 100 seeds weight, the highest weight obtained by interaction between ICARDA 2380 and control treatment.

Keywords: *Vicia narbonensis, lines, cutting height, growth, yield, yield components, dry matter percent*

Introduction

The genus Vicia is made up of approximately 190 species worldwide. The genus is primarily found in the Mediterranean and Irano- Turanian regions. However, the genus Vicia is widely distributed in the temperate zone of the northern hemisphere and in extra-tropical South America (Tahereh et al., 2012). Narbon vetch (*Vicia narbonensis* L.*)*, which is resistant to cold and drought, is an annual legume species (Açıkgöz, 2001; Fırıncıoğlu et al., 2012). Vetch can be grazed by animals as fresh forage (Haddad, 2006) or can be cut and preserved as hay and silage (Abdullah et al., 2010). Vetches hay can be used as a protein supplement, and their grains serve as energy and protein sources in the rations of ruminants and non-ruminants (Sadeghi et al., 2009).

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The potential of narbon vetch for grain production as livestock feed is greater than other vetch species, and the grain contains tannin and trypsin inhibitors that is directly affecting its efficiency of feed (Berger et al., 2002; Larbi et al., 2010), in general narbon vetch is cultivated for grain production (Buyukburc and Iptas, 2001). The species also has great importance in the system of crop rotation, either as pure stands or in a mixture with cereals for green forage or hay production to provide high-quality of livestock feed (Altınok, 2002; Altınok and Hakyemez, 2002; Iptaş and Karadağ, 2009; Nizam et al., 2011). Furthermore, narbon vetch is used as a valuable green manure plant, because it produce a high amount of green biomass, and its ability to fix large amounts of nitrogen to the soil as a legume (Albayrak et al., 2004a, b; Avcıoğlu et al., 2009; Fırıncıoğlu et al., 2012).

Narbon vetch is a fast-growing crop, with vigorous regrowth ability, and does better under warm temperatures and drier conditions (annual rainfall amount below 350 mm) than faba bean. It is tolerant to cold. When aerial parts damaged by frost may be die, but new shoots regrow when conditions will better in the spring. It can grow in many types of soils from sandy soils to loams provided they are well-drained. The input requirement of narbon vetch has low (fertilizer and pesticides) but does particularly well on alkaline soils and responds positively to P fertilizer (Mebarkia et al., 2013; Sanchez-Vioque et al., 2011). Like many other Vicia species, the culture of *Vicia narbonensis* L. has long been neglected due to the presence of anti-nutritional factors that also cause an undesirable odorand taste in grain and foliage. Once cooked, the anti-nutritional factors removed, and Narbon beans can be eaten and are described as being of high quality (Bryant et al., 2011).

Forage growers cut forages frequently at a height of 3-inches or more. However, recent reports indicate that there may be an advantage to cutting crop closer, leaving an inch or less of stubble height, which was found that annual alfalfa yields were 1.6 tons per acre higher when cutting at 1-inches compared to 5-inches heights (@griculture Online, 1999).

A study from West Virginia reports that alfalfa cut at 1 or 2 inches yielded as much as38% more than alfalfa cut at 4 inches (Belesky and Fedders, 1997). A reduction of a ½ ton of dry matter per inch as cutting height increased from 2 to 6 inches above the ground when combined across three harvests for the year (Wiersma, 2000).

However, there is little information available on the forage yield of narbon vetches grown under climatic conditions of Sulaimani. Therefore, the current study aimed to determine forage and seed yields for three varieties of narbon vetch (*Vicia narbonensis* L.) at different defoliation intensities, and which variety has ability to adapt with our condition and regrowth after defoliation to produce high yield crop.

Materials and methods

A field experiment was conducted at College of Agricultural Engineering Sciences-University of Sulaimani located (Latitude: 35 33’ N, Longitude 45° 27’ E, at altitude of approximately 830 m) during the winter season of 2017-2018, to study the effect of different varieties and defoliation intensities on growth, forage, seed yield and its components of narbon vetch (*Vicia narbonensis* L.) under rainfed condition conducting in split-plot design. Three varieties of narbon vetch (ICARDA 2561, ICARDA 2380 and ICARDA 2706) were implemented in the main plots and arranged according to the randomized complete block design (CRBD) and replicated three times, and four

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defoliation intensities (different height of forage cutting from ground level) (Control (not defoliated), Low = 8 cm, Moderate = 6 cm and Severe = 4 cm from ground level) were allotted in subplots for seed traits, but for forage traits treatments were allotted without control (Low = 8 cm, Moderate = 6 cm and Severe = 4 cm from ground level). Each subplot consists of 3 rows, 2 m long with 0.30 m apart between rows.

Sowing was conducted during 12th December 2017 according to the recommended seed rates 120 kg/ha for three varieties and all plots were fertilized with 120 kg P_2O_5/ha as triple superphosphate, which was broadcasting before sowing, and the germination percentage for each used varieties was higher than % 95. All required agricultural practices were used as needed. Forage cutting conducted for all subplots on 4th January 2018 to determine forage yield traits:

Forage yield traits

- Fresh Forage Yield (ton/ha)
- Dry Forage Yield (ton/ha)
- Fresh Leaf%
- Dry Leaf%
- Fresh Stem%
- Dry Stem%
- Dry Matter%
- Leaves/Stem Ratio

In addition, on the same day of cutting we were taken a sample randomly (5 plants of each subplot) to estimate forage yield component traits were:

Growth traits

- Plant height (cm)
- No. of Branches/plant
- No. of leaves/plant
- Leaves weight/plant (g)
- Dry leaves weight/plant (g)
- Stem weight/plant (g)
- Dry Stem weight/plant (g)
- Root weight (g)
- Dry Root weight (g)

When the plants matured physiologically, harvesting was carried out on 4th June 2018 to record seed yield traits from each plot, but the averages of 10 pods were taken from each plot to estimate yield component traits as follows:

Seed yield and its components

- Seed Yield (ton/ha)**,**
- Biological Yield (ton/ha)**,**
- Pods Number/m^2
- Pod yield (ton/ha)
- Average Pod Length (cm)

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- Average Seeds Number/Pod
- Average Seeds Weight/Pod (g)
- 100 Seeds Weight (g)

The data were statistically analyzed according to the methods of analysis of variance as a general test and combined analysis conducted (AL Mohamad and AL Younis, 2000). Comparison among the means was carried out using the least significant test (L.S.D) at a significant level of 5% and 1% (AL Mohamad and AL Younis, 2000).

Results and discussion

Data in *Table 1* and *Appendix 1* indicated that the effect of varieties on forage yield traits was not significant for most characters but on the other traits such as (fresh forage yield, dry forage yield and fresh leaf percent) were found to be significant, ICARDA 2561 gave maximum value of fresh forage yield (13.356 ton/ha), while ICARDA 2380 recorded minimum value of this trait which was (11.706 ton/ha). But the highest dry forage yield and fresh leaf percent were (1.492 ton/ha and 63.467%) respectively exhibited by V3, in which the lowest values of both traits were (1.302 ton/ha and 60.763%) recorded by ICARDA 2380 and ICARDA 2561 regularly. These differences among varieties may be due to genetic variance and capability of each variety for best production. These results were in agreement with the results of Muhammed (2017).

Table 1. *Effect of varieties on forage yield traits of narbon vetch*

Varieties	Fresh forage yield (ton/ha)	Dry forage yield (ton/ha)	Fresh leaf %	Fresh stem %	Dry leaf %	Dry stem %	Dry matter %	Leaves/stem ratio
ICARDA 2561	13.356	1.393	60.763	39.237	7.450	3.032	10.482	1.337
ICARDA 2380	11.706	1.302	63.358	36.642	7.957	3.167	11.123	1.082
ICARDA 2706	13.130	1.492	63.467	36.867	8.242	3.100	11.342	1.267
LSD ($P \leq 0.05$)	0.923	0.079	2.171	N.S	N.S	N.S	N.S	N.S

N.S: not significant

The results of *Table 2* and *Appendix 1* confirmed that the effect of defoliation intensities on all forage yield traits was significant except these characters' dry forage yield, dry stem percent, and dry matter percent were found to be not significant. Moderate defoliation intensity (6 cm) gave maximum values of fresh forage yield, fresh stem percent and leaves/stem ratio was (13.907 ton/ha, 39.971% and 1.356) respectively, while minimum values of fresh forage yield and fresh stem percent were (12.054 ton/ha and 35.404%) registered by low defoliation intensity (8 cm), but regarding leaves/stem ratio, minimum value was 1.062 obtained by severe defoliation intensity (4 cm).

Concerning both traits (fresh leaf and dry leaf percent), low defoliation intensity (8 cm) gave the best percent (64.929 and 8.283%) respectively, while the lowest percentage of these both traits were (60.029 and 7.606%) recorded by moderate defoliation intensity (6 cm).

In theory, leaving tall stubble and leaves at the base of the plant provides more photosynthetic area and energy for new stem growth following harvest. Prevision results showed that cutting to the soil surface increased forage yield at the first cut by

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increasing the weight of individual shoots harvested. This is simply because defoliation closer to the soil surface removed greater part of individual shoots of plants that had been uniformly managed prior to the first harvest. Plants at the first cut in the second-year growing season had stems arising mainly from the crown. This character- is tic of the plant canopy increased individual shoot weight steeply with decreasing cutting height reported by Shen et al. (2013), this result was in agreement with our results.

Table 2. *Effect of defoliation intensities on forage yield traits of narbon vetch*

Defoliation intensities	Fresh forage yield (ton/ha)	Dry forage yield (ton/ha)	Fresh leaf %	Fresh stem %	Dry leaf %	Dry stem %	Dry matter %	Leaves/stem ratio
Low (8 cm)	12.054	1.371	64.929	35.404	8.283	3.086	11.369	1.268
Moderate (6 cm)	13.907	1.483	60.029	39.971	7.606	3.081	10.687	1.356
Severe (4 cm)	12.231	1.334	62.630	37.370	7.760	3.132	10.892	1.062
LSD ($P \leq 0.05$)	0.656	N.S	1.103	1.216	0.401	N.S	N.S	0.166

N.S: not significant

Data represented in *Table 3* and *Appendix 1* showed that the effect of interactions between varieties and defoliation intensities on forage yield traits was significant on some traits such as fresh forage yield, fresh leaf percent, fresh stem percent, and leaves/stem ratio, but on the others was not significant. The interaction between ICARDA 2561 and moderate defoliation intensity (6 cm) gave the highest values of fresh forage yield and fresh stem percent were 15.587 ton/ha and 42.53% respectively, while the lowest yield of fresh forage was 11.291 ton/ha exhibited by interaction between ICARDA 2380 and low defoliation intensity (8 cm), and the lowest percent of fresh stem was 33.49% obtained by interaction between ICARDA 2380 and severe defoliation intensity (4 cm), also this interaction gave maximum fresh leaf percent 66.51%, in which minimum percent of fresh leaf was 57.47% recorded by ICARDA 2380 when treated with moderate defoliation intensity (6 cm). Regarding leaves/stem ratio, a maximum ratio was 1.432 showed by the interaction between ICARDA 2561 and low defoliation intensity (8 cm), in which the interaction between ICARDA 2380 and severe defoliation intensity (4 cm) recorded minimum leaves/stem ratio 0.532.

Table 4 and *Appendix 1* illustrated Effect of varieties on growth traits of narbon vetch, which was found that the effect was significant on plant height, leaves weight/plant, stem weight/plant and root dry weight, but on the other traits was not significant. The highest values of plant height, leaves weight/plant and stem weight/plant were (44.089 cm, 20.413 g, and 20.013 g) exhibited by ICARDA 2380**,** respectively, but maximum value of root dry weight was 0.922 g showed by variety 3, while the lowest values of these traits plant height, leaves weight/plant, stem weight/plant and root dry weight were (34.386 cm, 16.723 g, 12.490 g and 0.634) g recorded by (ICARDA 2706, ICARDA 2561, ICARDA 2561, and ICARDA 2380) respectively.

The differences between varieties in some growth traits may be positively and strongly related to the differences in genetic map and these adaptations to the climate. These results were in agreement with the results reported by (Muhammed, 2017).

Data in *Table 5* and *Appendix 1* confirmed that most growth traits of narbon vetch such as (no. of branches/plant, no. of leaves/plant, leaves weight/plant, leaves dry weight/plant and stem weight/plant) significantly affected by different defoliation intensities, while the other traits (plant height, stem dry weight/plant, root weight and root dry weight) not affected by this factor. Moderate defoliation intensity (6 cm) gave maximum values of

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(no. of branches/plant, no. of leaves/plant, leaves weight/plant and leaves dry weight/plant) were (2.919, 26.027, 21.941 g and 3.070 g) respectively, on the other hand, maximum stem weight/plant (17.721 g) presented by severe defoliation intensity (4 cm), in which minimum values of these traits (no. of branches/plant, no. of leaves/plant and leaves dry weight/plant) were (2.294, 20.257 and 2.259 g) appeared by severe defoliation intensity (4 cm), but concerning both traits (leaves weight/plant and stem weight/plant), the lowest values showed by low defoliation intensity (8 cm) which was (16.194 and 13.298) g respectively. Previous works confirmed that alfalfa growth in the spring is primarily from crown buds and depends on temperature and available root energy reserves. Shoot growth after the first harvest originates from both crown and auxiliary buds. When the crop is cut very short (1-inch or less) most of the axillary buds are removed and new shoots must come from the crown buds (Wiersma, 2000).

Table 3. *Effect of interactions between varieties and defoliation intensities on growth traits of narbon vetch*

Varieties	Defoliation intensities	Fresh forage yield (ton/ha)	Dry forage yield (ton/ha)	Fresh leaf %	Fresh stem %	Dry leaf %	Dry stem %	Dry matter %	Leaves/ stem ratio
ICARDA 2561	Low (8 cm)	11.918	1.323	65.97	34.03	8.213	2.887	11.100	1.432
	Moderate (6 cm)	15.587	1.537	57.47	42.53	7.010	2.843	9.853	1.316
	Severe (4 cm)	12.564	1.320	58.85	41.15	7.127	3.367	10.493	1.263
ICARD A 2380	Low (8 cm)	11.291	1.310	64.17	35.83	8.163	3.433	11.597	1.307
	Moderate (6 cm)	11.875	1.262	59.39	40.61	7.490	3.150	10.640	1.408
	Severe (4 cm)	11.950	1.334	66.51	33.49	8.217	2.917	11.133	0.532
ICARDA 2706	Low (8 cm)	12.954	1.479	64.65	36.35	8.473	2.937	11.410	1.066
	Moderate (6 cm)	14.257	1.651	63.22	36.78	8.317	3.250	11.567	1.344
	Severe (4 cm)	12.180	1.346	62.53	37.47	7.937	3.113	11.050	1.392
LSD ($P \leq 0.05$)		1.136	N.S	1.911	2.106	N.S	N.S	N.S	0.288

N.S: not significant

Table 4. *Effect of varieties on growth traits of narbon vetch*

Varieties	Plant height (cm)	No. of brunches/ plant	No. of leaves/plant	Leaves weight/plant (g)	Leaves dry weight/plant (g)	Stem weight/plant (g)	Stem dry weight/plant (g)	Root weight (g)	Root dry weight (g)
ICARDA 2561	37.123	2.550	22.101	16.723	2.243	12.490	1.456	2.449	0.729
ICARD A 2380	44.089	2.627	23.804	20.413	2.949	20.013	1.746	2.171	0.634
ICARDA 2706	34.386	2.626	22.923	17.541	2.582	14.572	1.583	2.528	0.922
LSD ($P \leq 0.05$)	1.692	N.S	N.S	2.465	N.S	3.427	N.S	N.S	0.116

N.S: not significant

Table 5. *Effect of defoliation intensities on growth traits of narbon vetch*

Defoliation intensities	Plant height (cm)	No. of brunches/ plant	No. of leaves/ plant	Leaves weight/ plant (g)	Leaves dry weight/ plant (g)	Stem weight/ plant (g)	Stem dry weight/plant (g)	Root weight (g)	Root dry weight (g)
Low (8 cm)	39.631	2.589	22.546	16.194	2.446	13.298	1.482	2.278	0.773
Moderate (6 cm)	38.311	2.919	26.027	21.941	3.070	16.057	1.880	2.410	0.740
Severe (4 cm)	37.656	2.294	20.257	16.542	2.259	17.721	1.422	2.460	0.772
LSD ($P \leq 0.05$)	N.S	0.317	1.726	0.727	0.312	2.010	N.S	N.S	N.S

N.S: not significant

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The results were obtained from *Table 6* and *Appendix 2* indicated that the effect of interactions between varieties and defoliation intensities on all growth traits was significant with the exception of the character root weight which was found to be not significant. The interaction between ICARDA 2380 and moderate defoliation intensity (6 cm) awarded the highest values of (plant height, no. of branches/plant, no. of leaves/plant, leaves weight/plant, leaves dry weight/plant and stem dry weight/plant) were (41.59, 3.553, 34.420, 33.537 g, 4.923 g, and 2.830 g) respectively, but the highest amount of stem weight/plant was 25.163 g offered by ICARDA 2380 when interacted with severe defoliation intensity (4 cm), and maximum root dry weight was (1.073 g) obtained by interaction between ICARDA 2706 and severe defoliation intensity (4 cm). while the lowest height of plant was 30.37 cm exhibited by interaction between ICARDA 2706 and low defoliation intensity (8 cm), but the minimum values of (no. of branches/plant, leaves dry weight/plant and stem weight/plant) were (2.107, 1.953 g and 11.067 g) showed by ICARDA 2380 when interacted with low defoliation intensity (8 cm) respectively. Regarding these traits (no. of leaves/plant, leaves weight/plant, stem dry weight/plant and root dry weight), the interaction between ICARDA 2380 and severe defoliation intensity (4 cm) gave minimum values were 17.997, 13.270 g, 1.087 g and 0.570 g, respectively.

Table 6. *Effect of interactions between varieties and defoliation intensities on growth traits of narbon vetch*

Varieties	Defoliation intensities	Plant height (cm)	No. of brunches/ plant	No. of leaves/ plant	Leaves weight/ plant (g)	Leaves dry weight/ plant (g)	Stem weight/ plant (g)	Stem dry weight/ plant (g)	Root weight (g)	Root dry weight (g)
ICARDA 2561	Low (8 cm)	38.21	3.110	25.533	18.610	2.590	13.000	1.597	2.497	0.780
	Moderate (6 cm)	38.89	2.430	21.773	15.957	2.083	12.123	1.430	2.510	0.733
	Severe (4 cm)	34.27	2.110	18.997	15.603	2.057	12.347	1.340	2.340	0.673
ICARDA 2380	Low (8 cm)	50.32	2.107	18.997	14.433	1.953	11.067	1.320	2.510	0.750
	Moderate (6 cm)	41.59	3.553	34.420	33.537	4.923	23.810	2.830	2.107	0.583
	Severe (4 cm)	40.36	2.220	17.997	13.270	1.970	25.163	1.087	1.897	0.570
ICARDA 2706	Low (8 cm)	30.37	2.550	23.107	15.540	2.793	15.827	1.530	1.827	0.790
	Moderate (6 cm)	34.46	2.773	21.887	16.330	2.203	12.237	1.380	2.613	0.903
	Severe (4 cm)	38.33	2.553	23.777	20.753	2.750	15.653	1.840	3.143	1.073
LSD ($P \leq 0.05$)		2.318	0.550	2.989	1.259	0.540	3.482	0.604	N.S	0.135

N.S: not significant

Data represented in *Table 7* and *Appendix 3* confirmed that the effect of varieties on all seed yield and its components traits was significant with the exception of the characters (pods number/m^2, pods length, and seeds weight/pod) which was found to be not significant. Maximum values of (biological yield, pod yield, average seeds number/pod and seed yield) were (5.082 ton/ha, 2.709 ton/ha, 3.554 and 2.040 ton/ha) respectively recorded by ICARDA 2706, but regarding 100 seeds weight, ICARDA 2380 gave the highest value which was 20.001 g, while ICARDA 2380 gave minimum value of biological yield 3.997 ton/ha, and ICARDA 2561 exhibited the lowest values of (pod yield, seeds number/pod and seed yield) were (2.092 ton/ha, 2.817 and 1.584 ton/ha) respectively, in which minimum weight of 100 seeds was 16.149 g registered by ICARDA 2706. The superiority of ICARDA 2706 in biological, seed yield and some other traits may be due to its adaptation in compare to other variety which

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was well adapted to the Sulaimani region climatic and soil conditions. This result agrees with the results of Baş et al. (2011).

Table 7. *Effect of varieties on seed yield and its components of narbon vetch*

Varieties	Biological yield (ton/ha)	Pods number/m^2	Pod yield (ton/ha)	Pods length (cm)	Seeds number/pod	Seeds weight/pod (g)	100 seeds weight (g)	Seed yield (ton/ha)
ICARDA 2561	4.464	215.333	2.092	4.939	2.817	0.624	16.180	1.584
ICARDA 2380	3.997	209.167	2.233	5.311	3.309	0.726	20.001	1.656
ICARDA 2706	5.082	244.250	2.709	4.673	3.554	0.628	16.149	2.040
LSD ($P \leq 0.05$)	0.319	N.S	0.271	N.S	0.497	N.S	1.127	0.312

N.S: not significant

All traits of seed yield and its components of narbon vetch were shown in *Table 8* and *Appendix 2* affected significantly by different defoliation intensities. Control (not defoliated) treatment gave the highest values of these traits (biological yield, pods number/m², pods weight/m², pod length, seeds number/pod, seeds weight/pod, 100 seed weight and seed yield) were (15.725 ton/ha, 735.89, 8.0767 ton/ha, 5.936 cm, 4.333, 0.910 g, 22.196 g and 6.201 ton/ha) respectively, in which the lowest values of these previous traits exhibited by severe defoliation intensity (4 cm) were (0.376 ton/ha, 20000, 0.12719 ton/ha, 5.132 cm, 2.323, 0.584 g, 10.378 g and 0.098 ton/ha) respectively. Previously Mitchell et al. (2010), who reported switch grass should not be harvested within below a 10-cm stubble height to ensure carbohydrate translocation to the plant crowns for setting new tiller buds and maintaining stand productivity.

Table 8. *Effect of defoliation intensities on seed yield and its components of narbon vetch*

Defoliation intensities	Biological yield (ton/ha)	Pods number/m^2	Pod yield (ton/ha)	Pod length (cm)	Seeds number/pod	Seeds weight/ pod (g)	100 seeds weight (g)	Seed yield (ton/ha)
Control (not defoliated)	15.725	735.89	8.077	5.936	4.333	0.910	22.196	6.201
Low (8 cm)	1.510	101.67	0.850	3.721	2.917	0.633	18.654	0.558
Moderate (6 cm)	0.447	34.111	0.325	5.108	3.333	0.510	18.546	0.184
Severe (4 cm)	0.376	20.000	0.127	5.132	2.323	0.584	10.378	0.098
LSD ($P \leq 0.05$)	0.377	47.321	0.253	1.344	0.502	0.201	1.495	0.398

N.S: not significant

Results of *Table 9* and *Appendix 2* confirmed that the effect of interactions between varieties and defoliation intensities on all seed yield and its component traits of narbon vetch were significant. Maximum values of these traits (biological yield, pods number/m^2, pod yield, seeds number/pod and seed yield) were attained by the interaction between ICARDA 2706 and control (not defoliated) treatment were (17.589 ton/ha, 794.33, 9.031 ton/ha, 4.600 and 6.999) ton/ha respectively, but the interaction between ICARDA 2561 and control (not defoliated) treatment gave the highest values of (pod length and seeds weight per pod) were (6.227 cm and 1.013 g) respectively, but concerning 100 seeds weight, the interaction between ICARDA 2380 and control (not defoliated) treatment gave the highest weight which was 24.820 g, while the minimum values of (biological yield and pod yield) were (0.098 and 0.046) ton/ha exhibited by interaction between ICARDA 2380 with severe defoliation intensity (4 cm), but when ICARDA 2561 interacted with severe (4 cm) defoliation intensity

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recorded the lowest values of (pods number/m^2, pod yield, seeds number/pod, 100 seeds weight, and seed yield) were (3.00, 0.008 ton/ha, 1.500, 5.227 g and 0.004 ton/ha) respectively. Regarding the average of pods length, minimum length exhibited by the interaction between ICARDA 2380 and low (8 cm) defoliation intensity which was 3.060 cm, and when ICARDA 2380 interacted with moderate (6 cm) defoliation intensity recorded minimum value of seeds weight/pod was 0.233 g.

Table 9. *Effect of interactions between varieties and defoliation intensities on seed yield and its components of narbon vetch*

Varieties	Defoliation intensities	Biological yield (ton/ha)	Pods number/m^2	Pod yield (ton/ha)	Pods length (cm)	Seeds number/pod	Seeds weight/pod (g)	100 seeds weight (g)	Seed yield (ton/ha)
ICARDA 2561	Control (not defoliated)	15.046	694.33	7.194	6.227	4.467	1.013	22.177	5.500
	Low (8 cm)	2.446	155.67	1.113	5.033	2.367	0.677	19.433	0.820
	Moderate (6 cm)	0.184	8.333	0.053	3.950	2.933	0.233	17.883	0.013
	Severe (4 cm)	0.180	3.000	0.008	4.547	1.500	0.572	5.227	0.004
ICARDA 2380	Control (not defoliated)	14.539	719.00	8.005	6.100	3.933	0.983	24.820	6.102
	Low (8 cm)	1.001	81.000	0.469	3.060	2.733	0.478	19.330	0.328
	Moderate (6 cm)	0.350	29.000	0.410	5.500	3.533	0.802	21.590	0.156
	Severe (4 cm)	0.098	7.667	0.046	6.583	3.037	0.641	14.263	0.036
ICARDA 2706	Control (not defoliated)	17.589	794.33	9.031	5.480	4.600	0.732	19.590	6.999
	Low (8 cm)	1.082	68.333	0.966	3.070	3.650	0.743	17.200	0.526
	Moderate (6 cm)	0.807	65.000	0.512	5.875	3.533	0.494	16.163	0.382
	Severe (4 cm)	0.850	49.333	0.328	4.267	2.433	0.540	11.643	0.253
LSD ($P \leq 0.05$)		0.653	59.826	0.437	59.826	0.870	0.349	2.590	0.690

N.S: not significant

Conclusions

From the results of this study, we concluded that most traits of growth, forage yield, seed yield and its components of narbon vetch were affected significantly by different varieties, defoliation intensities and their interactions as follow:

- The interaction between variety 1 and moderate defoliation intensity (6 cm) gave the highest values of fresh forage yield and fresh stem percent, and maximum fresh leaf percent exhibited by interaction between variety 2 and severe defoliation intensity (4 cm), but maximum leaves/stem ratio, showed by interaction between variety 1 and low defoliation intensity (8 cm).
- The interaction between variety 2 and moderate defoliation intensity (6 cm) awarded the highest values of plant height, no. of branches/plant, no. of leaves/plant, leaves weight/plant, leaves dry weight/plant and stem dry weight/plant, but the highest amount of stem weight/plant was offered by variety 2 when interacted with severe defoliation intensity (4 cm), and maximum root dry weight was obtained by interaction between variety 3 and severe defoliation intensity (4 cm).
- Maximum values of biological yield, pods number/m^2, pod yield, seeds number/pod, and seed yield were attained by the interaction between variety 3 and control (not defoliated) treatment, but the interaction between variety 1 and control treatment gave the highest values of pod length and seeds weight per

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pod, but concerning 100 seeds weight, the highest weight obtained by the interaction between variety 2 and control treatment.

Recommendation

We recommend from this study that there is a forage yield benefit to cutting or defoliation at shorter heights from ground level when the plants are not under stress or low in root carbohydrate levels, medium and high defoliation intensities significantly reduced available forage production. Seed production was adversely affected by defoliation intensity, and further study must be conduct at different locations and conditions to know the performance of these varieties.

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APPENDIX

Appendix 1. *Mean squares of variance analysis for forage yield traits of narbon vetch*

S.O.V	d.f	Fresh forage yield (ton/ha)	Dry forage yield (ton/ha)	Fresh leaf %	Fresh stem %	Dry leaf %	Dry stem %	Dry matter %	Leaves/ stem ratio
Blocks	r-1 = 2	0.018	0.011	0.186	0.573	0.209	0.196	0.765	0.065
A (varieties)	a-1 = 2	7.209*	0.081**	21.077*	18.598$^{n.s}$	1.449$^{n.s}$	0.041$^{n.s}$	1.798$^{n.s}$	0.156$^{n.s}$
Error (a)	(r-1)(a-1) = 4	0.497	0.004	2.751	3.097	0.416	0.074	0.329	0.040
B (defoliation intensities)	b-1 = 2	6.268**	0.036$^{n.s}$	36.061**	31.484**	0.757*	0.005$^{n.s}$	0.735$^{n.s}$	0.136*
AB	(a-1)(b-1) = 4	1.935*	0.022$^{n.s}$	17.090**	18.525**	0.302$^{n.s}$	0.174$^{n.s}$	0.320$^{n.s}$	0.200**
Error (b)	a(b-1)(r-1) = 12	0.408	0.017	1.154	1.402	0.153	0.166	0.360	0.026
Total	abr-1 = 26								

N.S: Not significant; *: Significant; **: Highly significant

Appendix 2. *Mean squares of variance analysis for forage yield component traits of narbon vetch*

S.O.V	d.f	Plant height (cm)	No. of branches/ plant	No. of leaves/ plant	Leaves weight/ plant (g)	Dry leaves weight/ plant (g)	Stem weight/ plant (g)	Dry stem weight/| plant (g)	Root weight (g)	Dry root weight (g)
Blocks	r-1 = 2	2.560	0.015	2.907	2.617	0.390	7.902	0.012	2.697	0.015
A (varieties)	a-1 = 2	225.2**	0.017$^{n.s}$	6.531$^{n.s}$	33.802*	1.121$^{n.s}$	135.8**	0.190$^{n.s}$	0.316$^{n.s}$	0.19**
Error (a)	(r-1)(a-1) = 4	1.672	0.117	4.784	3.548	0.582	6.857	0.390	0.258	0.008
B (defoliation intensities)	b-1 = 2	6.075$^{n.s}$	0.586*	50.65**	62.293**	1.083**	29.95**	0.371$^{n.s}$	0.053$^{n.s}$	0.002$^{n.s}$
AB	(a-1)(b-1) = 4	48.49**	0.632**	71.12**	108.95**	2.581**	49.8**	0.782**	0.518$^{n.s}$	0.03**
Error (b)	a(b-1)(r-1) = 12	1.698	0.096	2.823	0.501	0.092	3.832	0.115	0.409	0.006
Total	abr-1 = 26									

N.S: Not significant; *: Significant; **: Highly significant

Appendix 3. *Mean squares of variance analysis for seed yield and its components of narbon vetch*

S.O.V	d.f	Biological yield (ton/ha)	Pods number/m^2	Pod yield (ton/ha)	Pod length (cm)	Seeds number/pod	Seeds weight/pod (g)	100 seeds weight (g)	Seed yield (ton/ha)
Blocks	r-1 = 2	0.291	220.583	0.019	0.170	0.373	0.046	2.547	0.011
A (varieties)	a-1 = 2	3.554**	4210.083$^{n.s}$	1.257**	1.232 $^{n.s}$	1.693*	0.040$^{n.s}$	58.87**	0.721*
Error (a)	(r-1)(a-1) = 4	0.079	1693.917	0.057	3.122	0.192	0.045	0.988	0.076
B (defoliation intensities)	b-1 = 3	505.1**	1063994**	132.262**	7.612*	6.445**	0.274**	225.6**	79.240**
AB	(a-1)(b-1) = 6	2.420**	5010.82**	0.632**	3.681 $^{n.s}$	0.716*	0.113*	18.11**	0.443*
Error (b)	a(b-1)(r-1) = 18	0.145	1216.324	0.065	1.842	0.257	0.041	2.279	0.162
Total	abr-1 = 35								

N.S: Not significant; *: Significant; **: Highly significant

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