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Effect of different nitrogen application rates, date of harvest, and sowing distances on the productivity and nutritional value of Quinoa in view to its adoption as roughage crop for ruminants

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Introduction

- Lebanon, as many other countries, is affected by the global warming and drought resistant crops are searched.
- One of the main challenges in Lebanon, is to find an affordable roughage able to replace (or complete) the alfalfa and corn silage, specially in northern Bekaa valley where land is deteriorated and no longer used for forage production.
- Lebanon have seasonal rainfall (between September and May). Quinoa cultivation designated for roughage, between March and April, will be considered as a rainfed crop and does not affect the farmer's seasonal cycle.
- The highly vegetative growth of quinoa, allow it to be used as a roughage in the animal nutrition, mainly in this time, when farmer consider the concentrate as a basic meal for animals ; since the used roughage by nearly 80% of large ruminants is shopped hay (tibn).
- Finding a new low cost seasonal roughage and adding it to the list of existing roughages in the world, is our purpose in this study.

Materials and Methods

Experimental site

Two experiments were carried out under rain-fed conditions of the Lebanese Agricultural Research Institute (LARI), Tal Amara station. LARI is located in Bekaa valley at an altitude of 905 m, Latitude 33° 51′ 51″ N, Longitude 35° 59′ 11″ E and situated at 60 km south of Beirut.

Climate characterization

- Semi-arid conditions :
  - Minimum temperature : - 5º C.
  - Maximum temperature : + 34 º C.

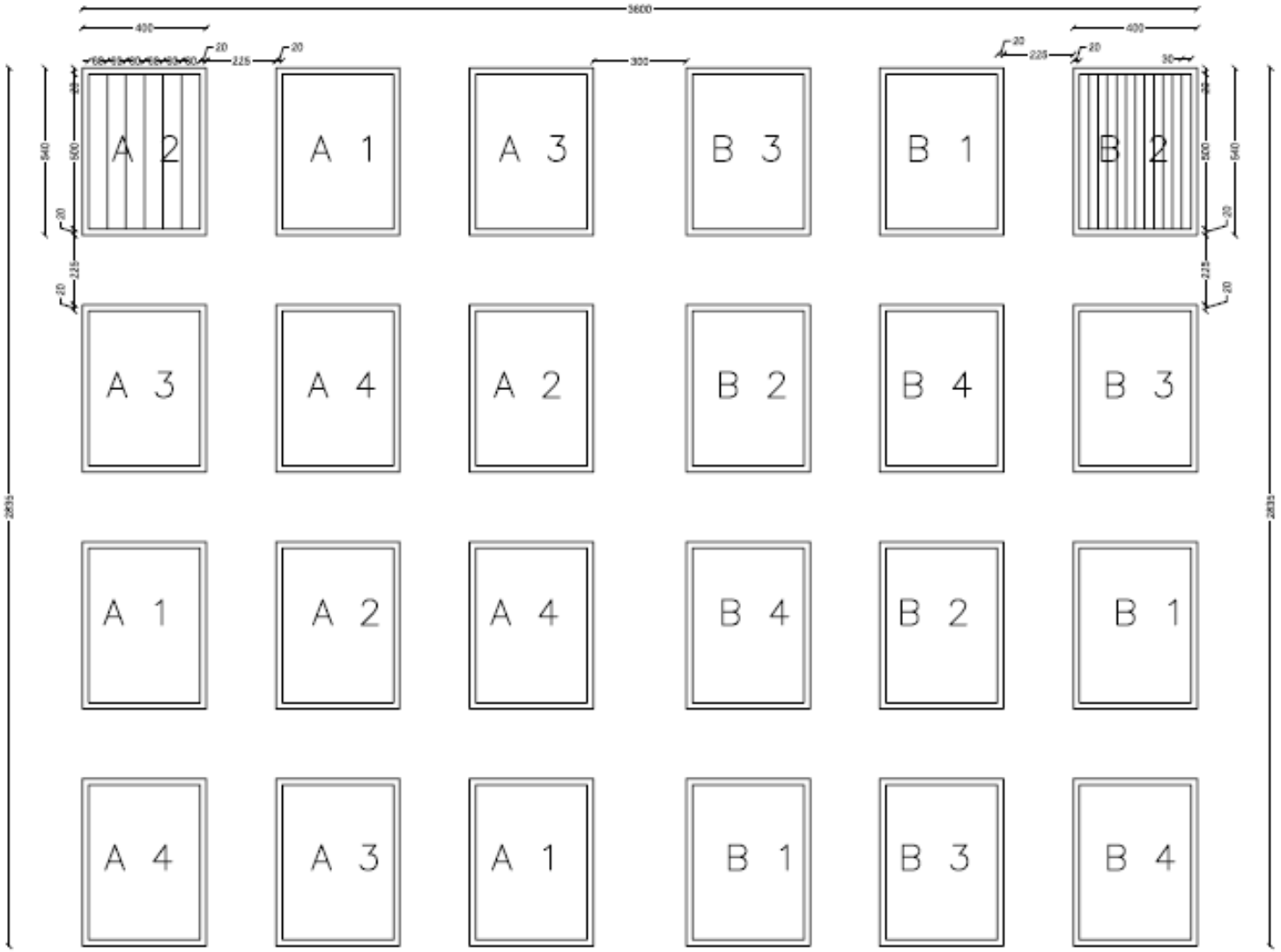
  - Maximum relative humidity : 70% in winter.
  - Minimum relative humidity : 40% in summer.

  - Average annual precipitation : 595 mm.
  - Precipitation season : from September till May.

  - Maximum soil temperature : + 25 ºC in summer.
  - Minimum soil temperature : 8.5 ºC in winter.

Ref: LARI meteorological department.

Experimental design



Experimental design

- ✓Experimental model: RCBD
- ✓Inter-lines spacing : “A” 60 cm (first exp) ; “B” 30 cm(second exp).
- ✓Inter-blocks spacing : 225 cm ; 3 m between experiments.
- ✓Block area : 20 m2 (4 m x 5 m).
- ✓Sown varieties : a mix of early maturing varieties Q12 (Peruvian landrace).
- ✓Seed germination : 88%.
- ✓Soil sampling : 10/3/2015 ; [0-20 cm], [20-40 cm], [40-60 cm]
- ✓Soil preparation : 14 & 17/3/2015.
- ✓Soil fertility correction : 30/3/2015.
- ✓Sowing date : 7/4/2015.
- ✓Complete germination : 2/5/2015.
- ✓Manual weeding : 6/5/2015, 26/5/2015.

Experimental design

✓Inter-block mechanical weeding : 22/5/2015, 10/6/2015.

✓Insecticide treatment : Carbaryl (spodoptera), Imidacloprid (aphidis).

✓Treatments : 0 N/ha, 90 N/ha, 180 N/ha, 270 N/ha.

✓Fertilizer application : 14/5/2015 (Amonium sulfate).

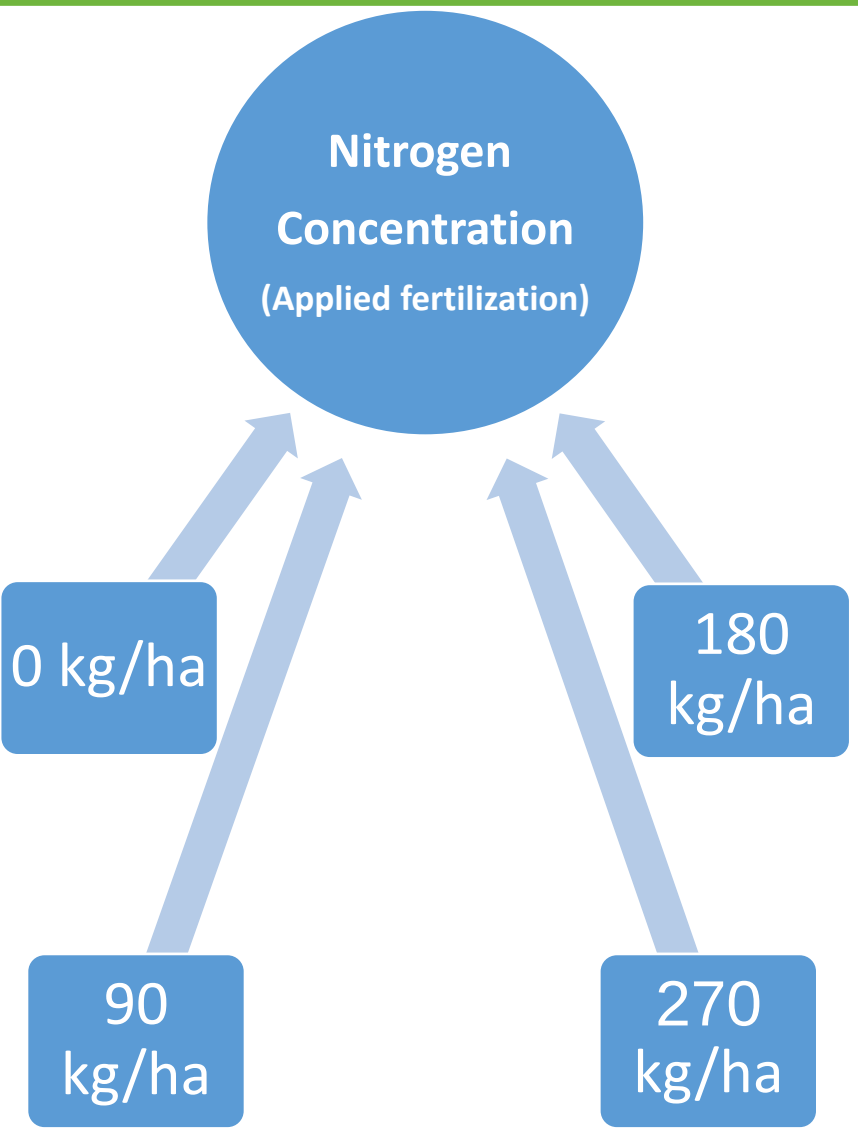
✓Irrigation: 14/5/2015 (3h:30min ~ 15.75 mm), 28/5/2015 (4h:30min ~ 20.25mm), 11/6/2015 (8 hrs ~ 36 mm), 26/6/2015 (8hrs ~ 36 mm) ➔ 108 mm.

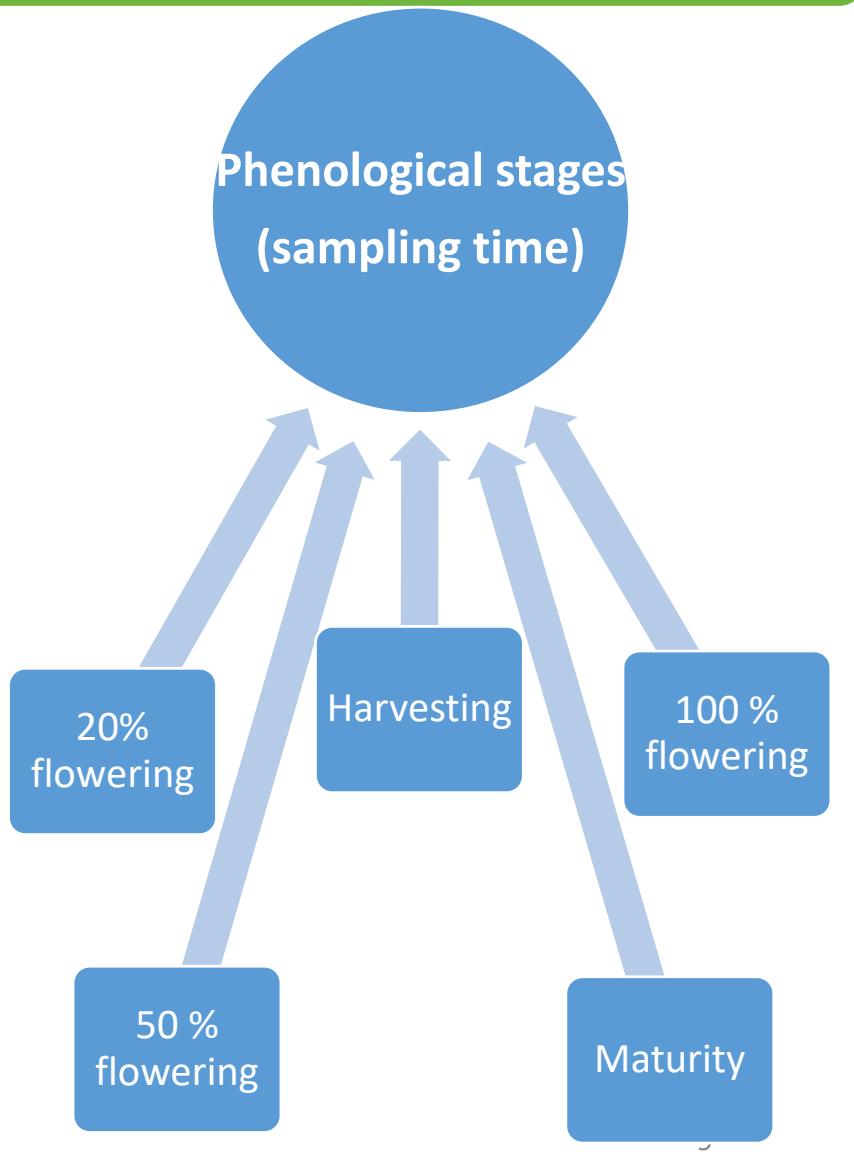
✓Sampling material: Frame 2,500 cm^2 (50 cm x 50 cm).

✓Sampling stages :

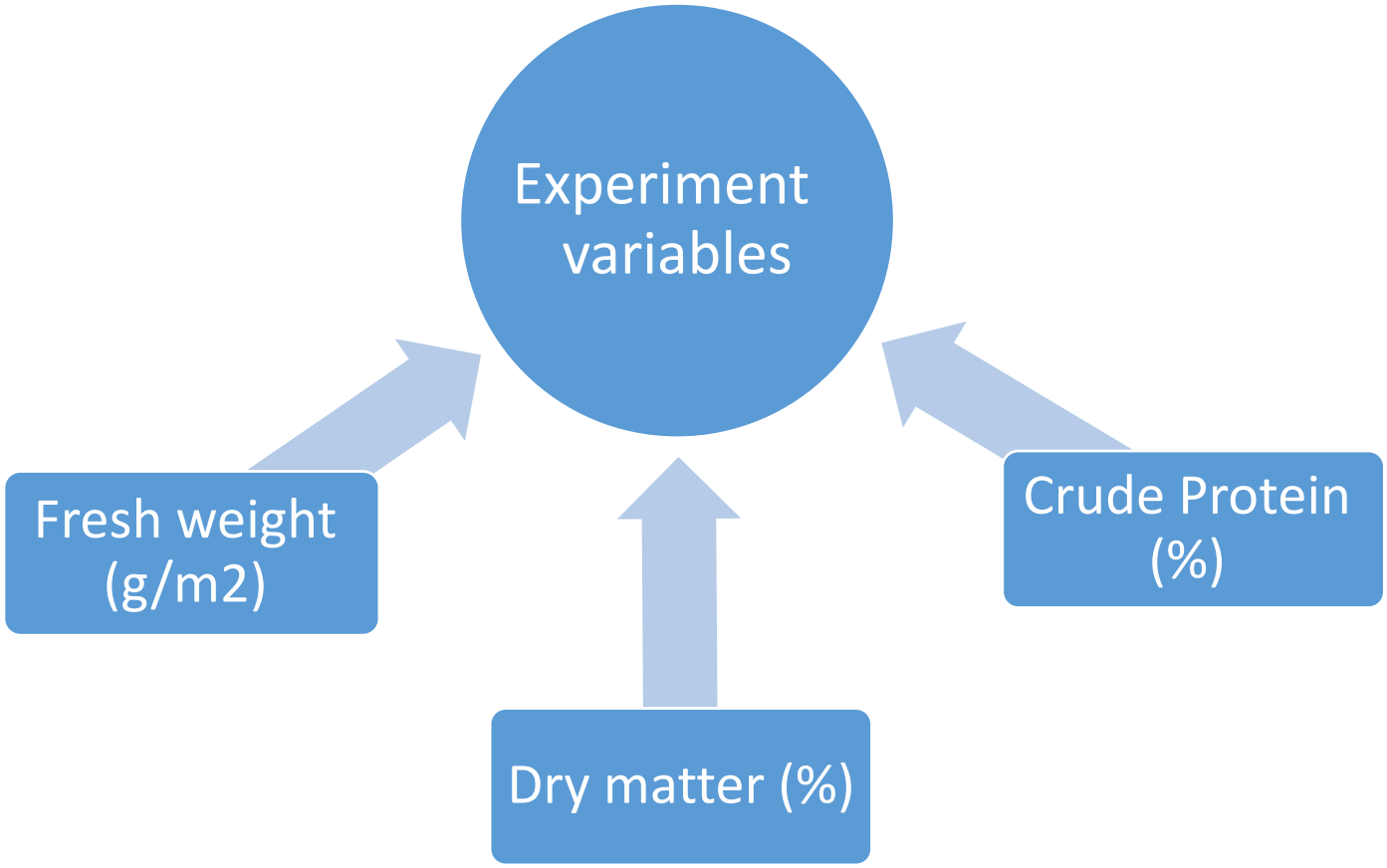
1. 20% flowering : 27/6/2015.
2. 50% flowering : 2/7/2015.
3. 100% flowering : 6/7/2015.
4. Maturity : 11/7/2015.
5. Manual harvesting : 27/7/2015.
6. Mechanical harvesting : 6/8/2015.

Applied treatments





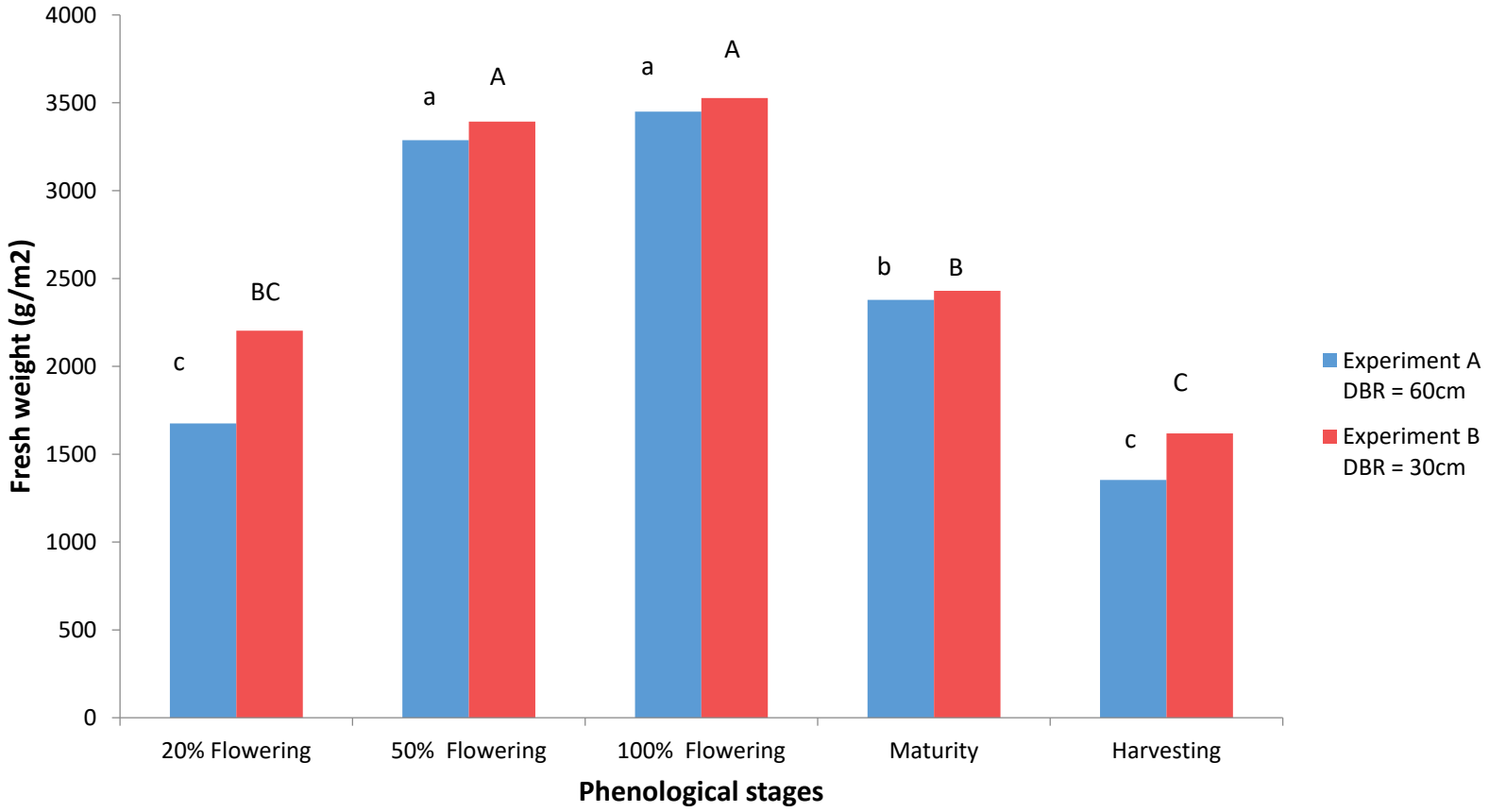
Studied variables



P.S. : Crude fiber, NDF, ADF, ADL, Gross energy, Ash, Minerals & Fat will be tested in 2017 and data will be added later.

Results

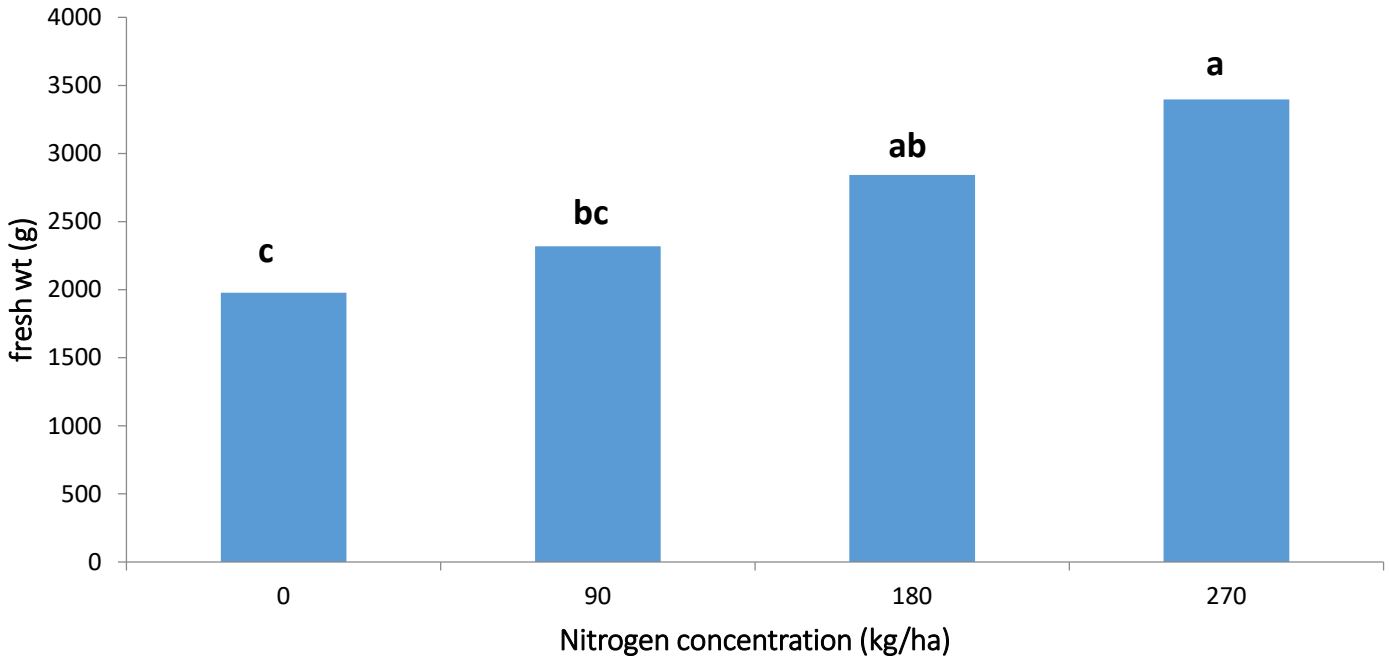
Fresh weight vs. Phenological stages



Highest fresh weight:

- Experiment A: 3450 g/ m^2 at 100 % flowering
- Experiment B: 3527 g/m^2 at 100 % flowering

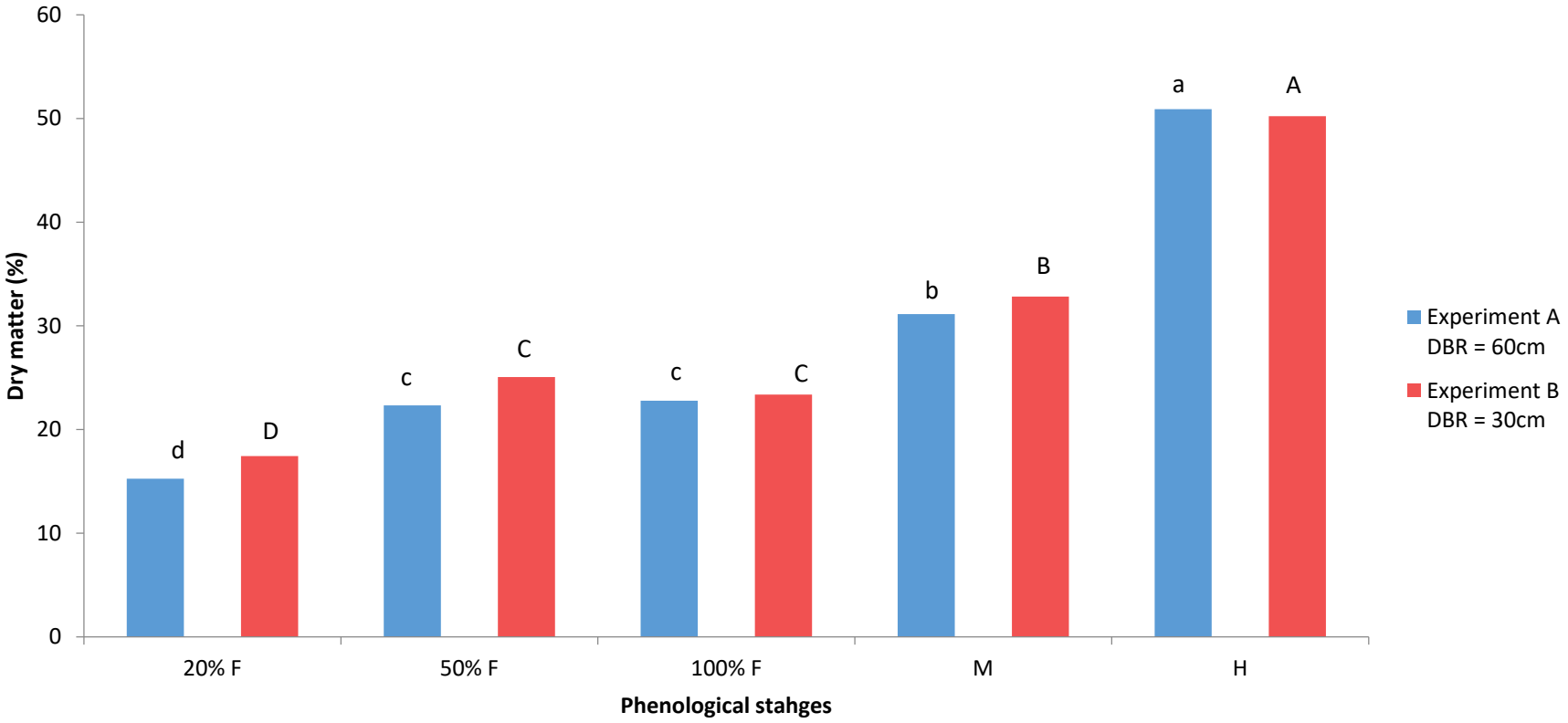
Fresh weight vs. Nitrogen concentration



In the experiment "B", the highest value of fresh weight is 3397.333 g/m2 obtained with 270 kg N/ha

No effect of Nitrogen concentration (*P=0.107*) on fresh weight (g/m2) was noticed in the experiment A (60 cm DBR).

Dry Matter (%)

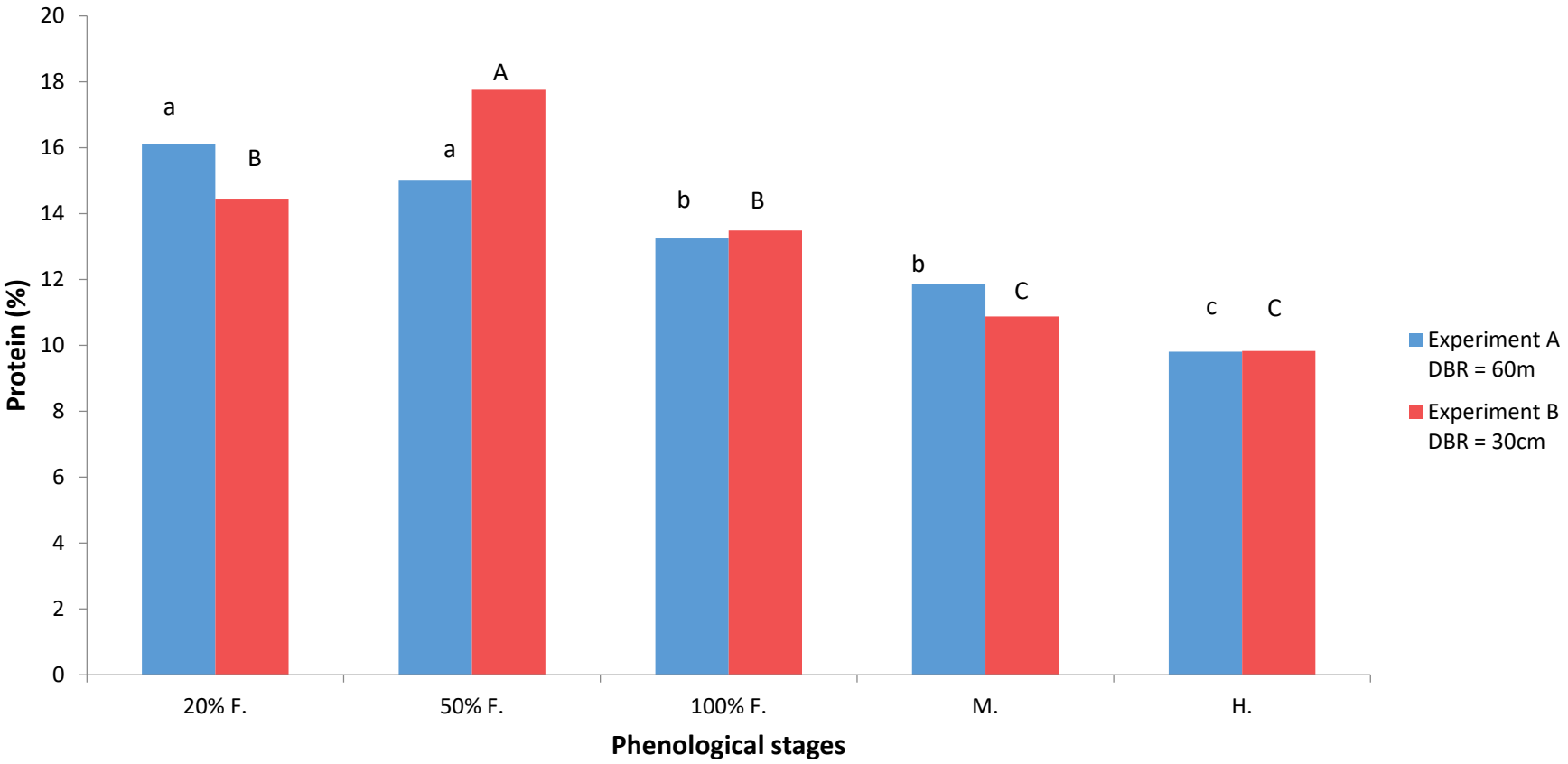


Highest Dry matter:

- Experiment A: 50.896 % at harvesting
- Experiment B: 50.226% at harvesting

No effect of Nitrogen concentration on dry matter (%) in both experiments.

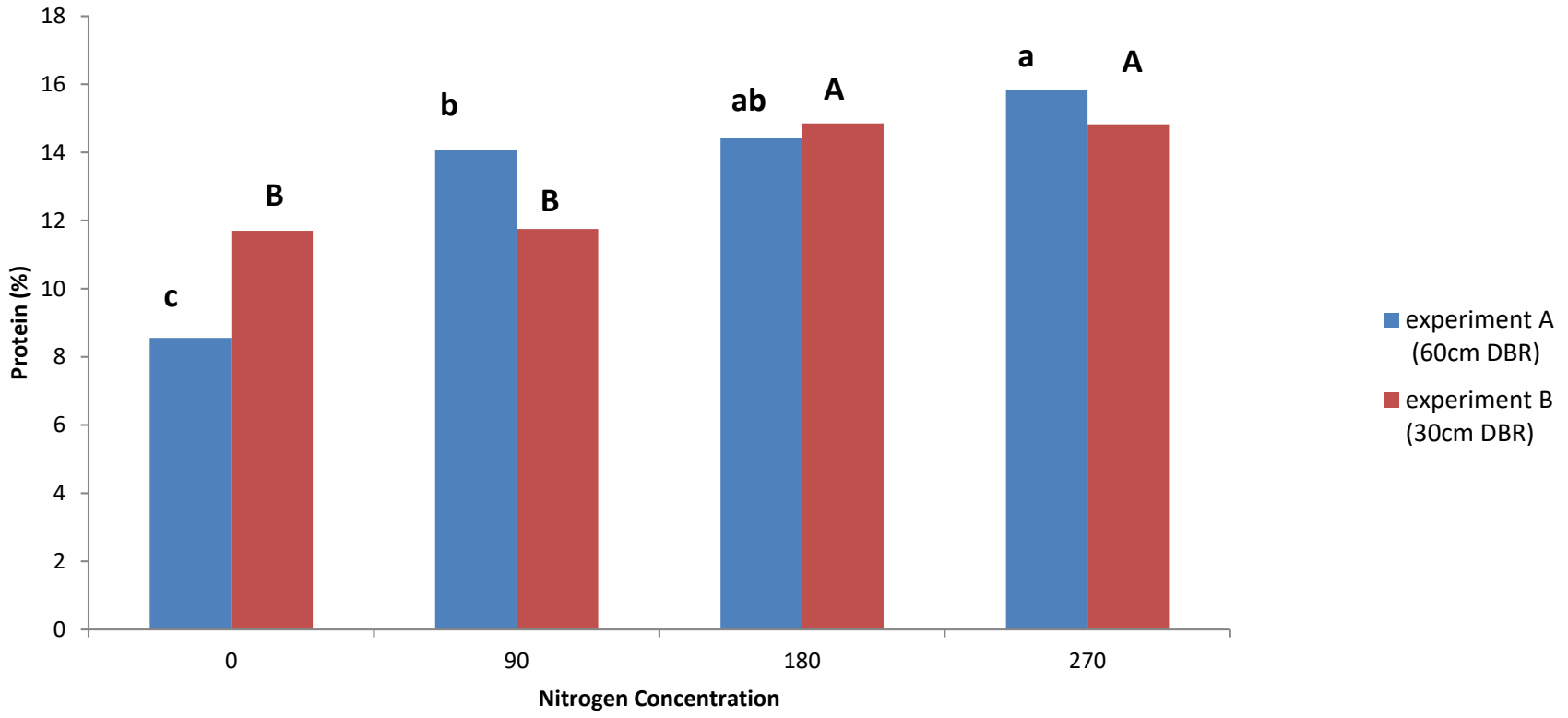
Crude Protein vs Phenological stages



Highest protein concentration:

- Experiment A: 16.111% at 20 % flowering
- Experiment B: 17.759% at 50 % flowering

Crude protein (%) vs. Nitrogen concentration



Nitrogen fertilization increase the Crude Protein% in quinoa plant. The highest CP% value:

- Experiment A: 16.117% at 20% flowering
- Experiment B: 17.759% at 50% flowering

Conclusion

Fresh weight

- Highest yield obtained at 100% flowering in both experiment and with different level of fertilizer

DM (%)

- The highest value at harvesting in both experiment

CP%

- Crude Protein highly affected by Nitrogen concentration.
- The highest value obtained at 20% flowering in the experiment A and at 50% flowering in the experiment B.

Recommendations

- Based on what proceeded, and due to saponin content increase with the advanced morphological stages ; It’s recommended to cultivate the quinoa with 30 cm distance between rows, and to cut it at 50% flowering stage, in order to be used as a roughage.

Future actions

- Complete the lab analysis for: Crude fiber, NDF, ADF, ADL, Gross energy, Ash, Minerals & Fat.
- Test the ensiling process.
- Test the palatability for quinoa hay and silage on animals.

Thank you for your kind attention