ILSA
AGROTECNOLOGIE

Nutrition aspects and

fertilizer recommendations on

QUINOA
(*Chenopodium quinoa)*

Contents:

1. General features

Quinoa (*Chenopodium quinoa*, Willd.) belongs to the family of *Chenopodiaceae*. It is considered a rich-protein pseudocereal, such as amaranth (*Amaranthus* spp., L.) and buckwheat (*Fagopyrum esculentum*, Moench), due to its high nutritional value and use in human nutrition.

It contains saponines in the external tissue of the seeds and characterize its bitter taste: the larger amount is removed after the harvest.

The protein quality and quantity in quinoa seed is often superior to those of more common cereal grains. Quinoa is higher in lysine than wheat, and the amino acid content of quinoa seed is considered well-balanced for human and animal nutrition, similar to that of casein (Table 1).

Table 2 – Essential amino acid pattern of quinon compared to wheat, soy, skim milk, and the FAO reference pattern (1973) for evaluating proteins

Amino Acid	Amino Acid Content (g/100g protein)				
	Quinoa	Wheat	Soy	Skim Milk	FAO
			%		
Isoleucine	4.0	3.8	4.7	5.6	4.0
Leucine	6.8	6.6	7.0	9.8	7.0
Lysine	5.1	2.5	6.3	8.2	5.5
Phenylalanine	4.6	4.5	4.6	4.8	-
Tyrosine	3.8	3.0	3.6	5.0	-
Cystine	2.4	2.2	1.4	0.9	-
Methionine	2.2	1.7	1.4	2.6	-
Threonine	3.7	2.9	3.9	4.6	4.0
Tryptophan	1.2	1.3	1.2	1.3	1.0
Valine	4.8	4.7	4.9	6.9	5.0

It is an annual herbaceous crop: sowing time depends on variety, environmental and climatic conditions and occurs in the period between the middle of September and the middle of November. Crop cycle lasts approximately 180 days (fig. 1):

- 4-6 days after sowing (das) → *emergence*;
- 10-15 das → *2 true leaves*;
- 25-30 das → *4 true leaves*;
- 35-45 das → *6 true leaves*;
- 45-50 das → *ramification*;
- 55-60 das → *panicle initiation*;
- 65-75 → *panicle formation*;
- 75-80 das → *beginning of flowering*;
- 80-90 das → *full flowering*;
- 100-130 das → *grain milky stage*;
- 130-160 das → *grain dough stage*;
- 160-180 das → *fully ripe*.

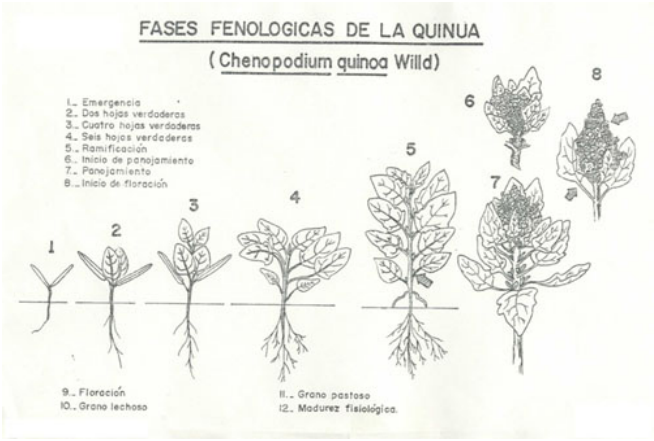

Figure 1 – Phenological stages of Quinoa

Its origin is in South America and it was largely cultivated by the Pre-Columbian populations, being considered sacred.

Nowadays it continues to be cultivated in South America, in particular in Peru and Bolivia and in smaller quantities in Ecuador: in 2010 total production was 78000 Mt in 35000 ha with a mean yield of 0.8 Mt/ha as shown in table 2:

Table 2 – Total production, cultivated area and mean yield of Quinoa (FAO, 2010)

Country	Total production (Mt)	Total cultivated area (ha)	Mean Yield (Mt/ha)
Peru	41079	35313	1.163
Bolivia	36106	63010	0.530
Ecuador	840	990	0.848
Total	**78025**	**99313**	-

2. Main factors affecting quinoa production

Quinoa is characterized by its resistance to extreme environmental and climatic conditions.

It prefers clay-loam soils with good nutrient content and drainage and a pH range between 6 and 8.5, but it is cultivated even in acid or alkaline soils. It is tolerant to extreme soil salinity values, such as 52 mS/cm.

It also grows at high altitudes (up to 4000 m a.s.l.) and generally it is cultivated in area between 2500 and 4000 m a.s.l.

Optimal mean temperatures are 10-18°C and it can resist both to high (30-32°C) and low temperature (0-2°C), except during flowering.

It is a C 3 plant and it is short-day in the equatorial area, while it is day-neutral in the other area.

It can resist to drought stress, but a supply of 300-1000 mm during the vegetative stages ensures a good development.

Quinoa has a good response to fertilization, in particular to Nitrogen.

3. Plant nutrition

During the cycle, quinoa starts to accumulate biomass in the panicle about 85 days after sowing, increasing 105 days after sowing (figure 2); at the end of the cycle biomass in the panicle represents the 60% of the total plant biomass, as shown in figure 3.

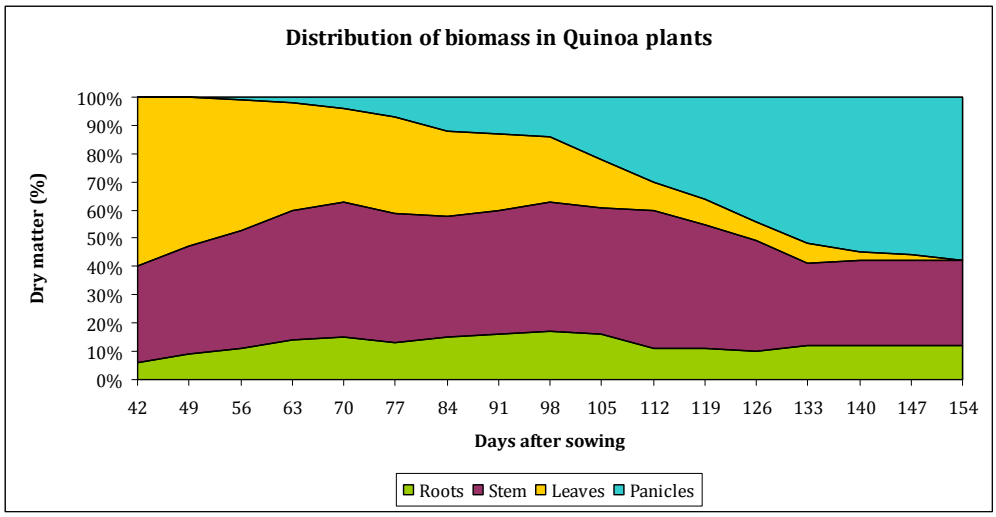

Figure 2 – Trend of biomass accumulation in quinoa during the crop cycle

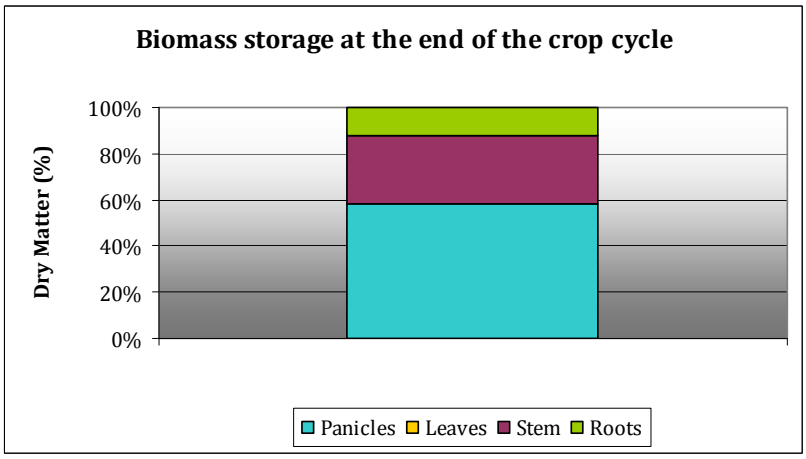

Figure 3 – Biomass storage in the different plant organs at the end of the cycle

It was found that the physiological balance of the variety Blanca de Junín in two different locality of Peru corresponds respectively to 50-16-34% of N-P_2O_5-K_2O in Canaán (2750 m a.s.l.) and 44-12-44% of N-P_2O_5-K_2O in Acocro (3500 m a.s.l.). Plant analysis reports the following values for the macronutrients (fig. 4):

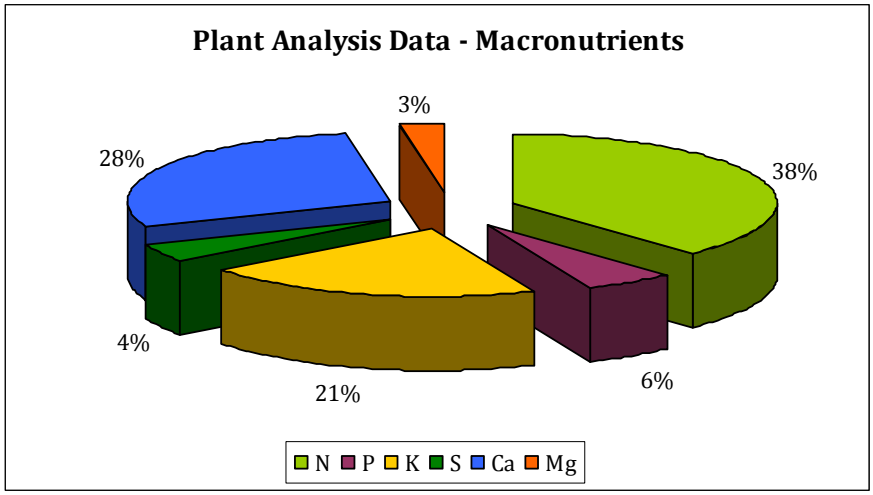

Figure 4 – Plant analysis data: Nitrogen and Potassium have an important role, but also high amount of Calcium is required

Nutrient uptake increases intensively from the second month after sowing and continues until 100 days after sowing (fig. 5): this period corresponds to the stages of the crop cycle when plant development and biomass accumulation are more intensive (fig. 6).

Some agronomic investigations report the index of NUE for Nitrogen and Phosphorus: it was found that the N-NUE can range from 11-15 to 22 kg/ha of yield for unit of Nitrogen and the P-NUE varies between 30 and 43 kg kg/ha of yield for unit of Phosphorus. A good N:P:K ratio was found to correspond to 1:0,75:1.

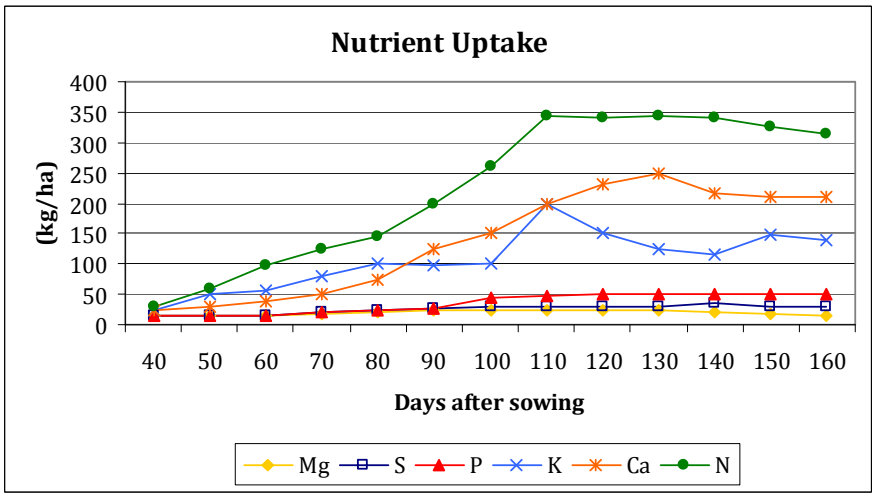

Figure 5 – Nutrient uptake during the crop cycle of quinoa: the maximum uptake occurs from 60 to 110 days after sowing. Quinoa absorbs high quantities of Nitrogen, Calcium and slightly less of Potassium

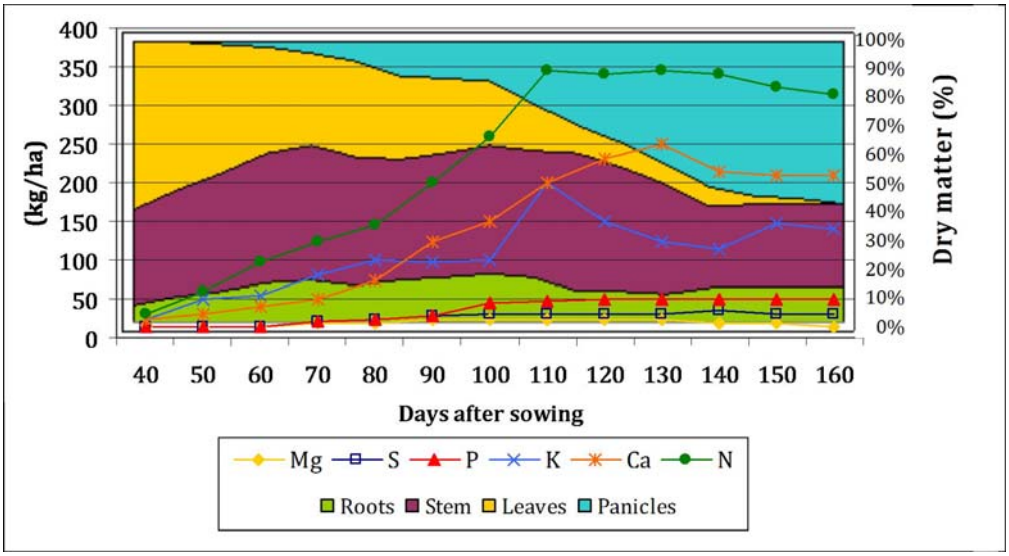

Figure 6 – Correspondence between nutrient uptake and biomass accumulation: it is evident that the interval between 100 and 120 days after sowing is critical because it is important to ensure the adequate amount of nutrients to sustain the final production

4. Fertilizer recommendations

In the Andes crop rotation is commonly practiced alternating quinoa to potato. In this case the usual practice is not to fertilize or applies only an additional fertilizer amount. On the other hand fertilization is used when quinoa succeeds cereal crops.

Generally organic matter is introduced in soil through sheep and goat manure (5-10 Mt/ha), guano (1-2 Mt/ha) and chicken manure (2.5 Mt/ha). Organic matter is applied during bed preparation. Nutrients are generally applied through urea, calcium triple superphosphate and potassium chloride. Split Nitrogen application is preferred, usually two applications at sowing and during the weeding or hilling in the Andes; three application at sowing, weeding/hilling and before flowering in the coastal areas where the risk of environmental losses is larger.

Ilsa fertilizer programs may include two fertilizers that cover the whole crop cycle:

- BIOILSA NPK 7.7.7. is a pelletizer organo-mineral NPK fertilizer. It only contains organic Nitrogen deriving from Agrogel® and it is allowed in organic agriculture. It can be applied at sowing, preferably incorporated in soil.
- FERTIL N 12.5 is a pelletizer organic Nitrogen fertilizer that contains exclusively organic Nitrogen deriving completely from Agrogel® and it is allowed in organic agriculture. It can be applied at the panicle formation (about 60 days after sowing) in order to provide Nitrogen during the period of the highest demand. Its maximum efficiency can be obtained if application is localized near the plant at a soil depth of 5-10 cm.

Ilsa fertilizers are characterized by a slow release of the organic Nitrogen: Nitrogen is released mainly in the first period, then its release is lower but constant; periodical applications ensure a constant availability of Nitrogen.

5. References

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