

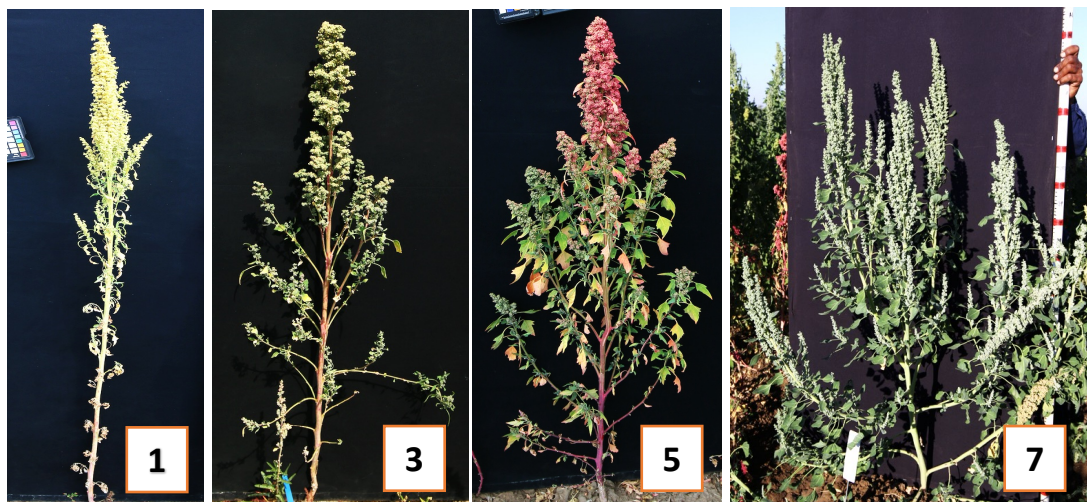
Plot population homogeneity

1	3	5	7
Most plants are the same (up to 10% different)	10 to 30% of plants different	30 to 50% of plants different (less than half are different)	Over 50% of plants are different (completely mixed)

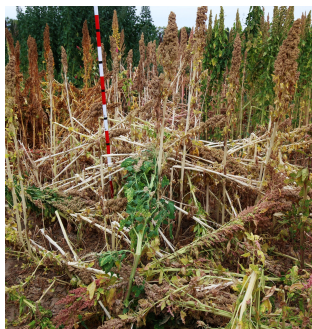
Growth habit

1	3	5	7
Not branched at base	Some branching from base, no significant panicles	Branching from base with more significant panicles	Main panicle can't be identified

Growth habit examples



Stem breakage



Stem lodging



Percentage of the plot affected

1- up to 20%

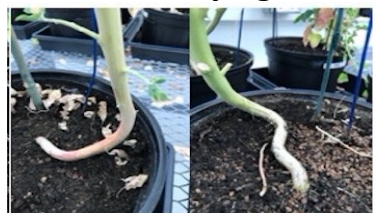
3 ~ 30% (20% – 40%)

5 ~ 50% (40% – 60%)

7 ~ 70% (60% – 80%)

9 - over 80 %

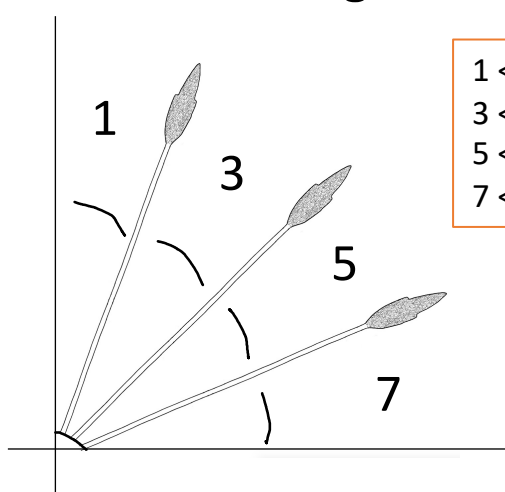
Stem lying



Seeds



Stem angle



1 < 22.5°

3 < 45°

5 < 67.5°

7 < 90°



Erectness of the stems of the majority of the plot:

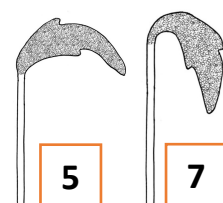
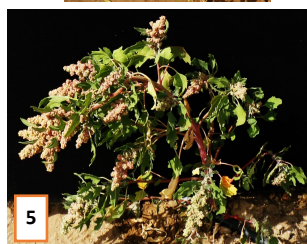
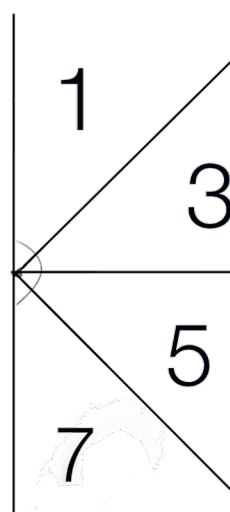
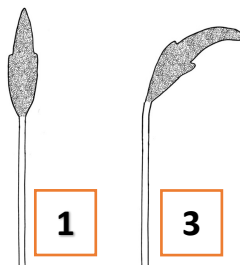
1 = "soldiers" to

7 = plants are severely lodged and on or near the ground

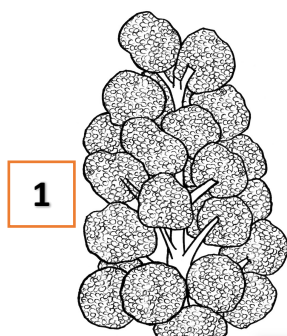
Panicle axis angle



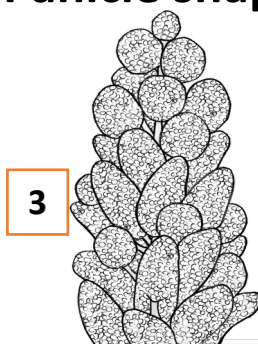
$1 < 45^\circ$
 $3 < 90^\circ$
 $5 < 135^\circ$
 $7 < 180^\circ$



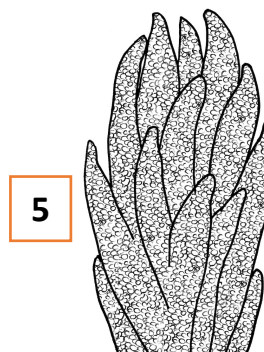
Panicle shape



Glomerulate:
 glomerules with
 globose shape—
 “bulbous clusters”



Intermediate: panicles
 express both
 amarantiform and
 glomerulate traits



Amarantiform:
 glomerules with
 elongated shape –
 “fingers”

Panicle shape



Panicle density

1

Lax (loose)

Glomerules
sparsely
spaced,
panicle axes
easily visible

3

Intermediate

Glomerules
tighter but with
panicle axes still
visible

5

Rarely seeing
primary axis

7

Compact

Glomerules
tightly packed,
no panicle axes
visible

Panicle density



Panicle leafiness

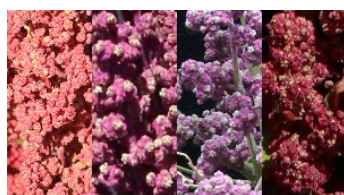


Panicle color



Green

13



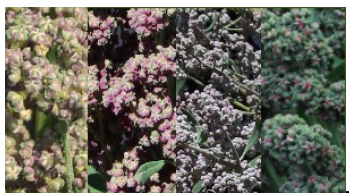
Pink / Purple / Red

4



Beige / White

15



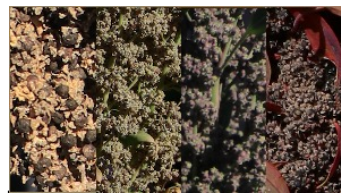
Green with Purple

16



Orange / Yellow

5



Dark coloured

7

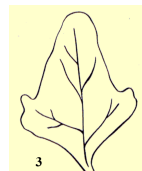
Stem leaf shape



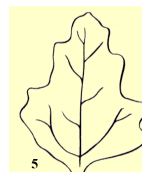
Rhomboidal (1)



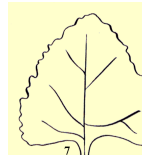
Triangular (2)



Entire (1)



Dentate (3)



Serrate (5)

Growth stage

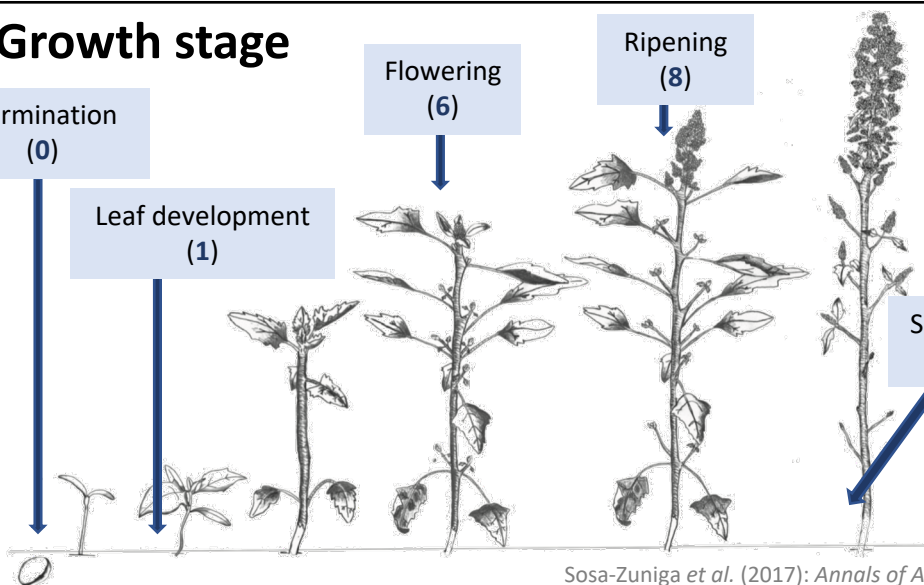
Germination
(0)

Leaf development
(1)

Flowering
(6)

Ripening
(8)

Senescence
(9)



Sosa-Zuniga et al. (2017): *Annals of Applied Biology*



BBCH Code Two-digit Description (Sosa-Zuniga et al. 2017)

Principal growth stage 0: germination

- 00 Dry seed
- 01 Initiation of seed imbibition
- 03 Seed imbibition completed
- 05 Radicle emergence from seed
- 07 Emergence of hypocotyl
- 08 Hypocotyl with cotyledons growing towards soil surface
- 09 Emergence of cotyledons through soil

Principal growth stage 1: leaf development

- 10 Cotyledons fully emerged
- 11 First pair of leaves visible
- 12 Second pair of leaves visible
- 19 Nine pair of leaves visible. If required, coding can continue following the same scheme.

Principal growth stage 2: formation of side shoots

- 20 Visible lateral buds or expanded leaves without lateral stems
- 21 One side shoot visible
- 22 Two side shoots visible
- 29 Nine side shoots visible. If required, coding can continue following the same scheme.

Principal growth stage 3: stem elongation (omitted)

Principal growth stage 4: development of harvestable vegetative parts (omitted)



Principal growth stage 5: inflorescence emergence

- 50 Inflorescence present but still enclosed by leaves
- 51 Leaves surrounding inflorescence separated, inflorescence is visible from above
- 59 Inflorescence visible, but all the flowers are still closed

Principal growth stage 6: flowering

- 60 Beginning of anthesis: main inflorescence flowers with first extruded anthers
- 67 Early end of anthesis: main inflorescence flowers with first senesced anthers
- 69 Complete anthesis: main inflorescence flowers with senesced anthers

Principal growth stage 7: fruit development

- 70 Fruit set: ovary thickening and first visible grains in the main stem

Principal growth stage 8: ripening

- 81 Milky grain, easily crushed with fingernails, liquid content and green pericarp
- 85 Thick grain, easily crushed with fingernails, white pasty content, green, beige, red or black pericarp
- 89 Ripe grain, difficult to crush with fingernails, dry content, the grain has a beige, red or black color on its outside. Ready to harvest.

Principal growth stage 9: senescence

- 91 Only basal leaves are dry
- 93 Leaves of the first half portion of the plant, starting from the base, are dead
- 95 All leaves are dead; stem colour turns from yellow to brown
- 97 Plant dead and dry
- 99 Harvested product



BBCH scale examples



52



53



54

BBCH scale examples

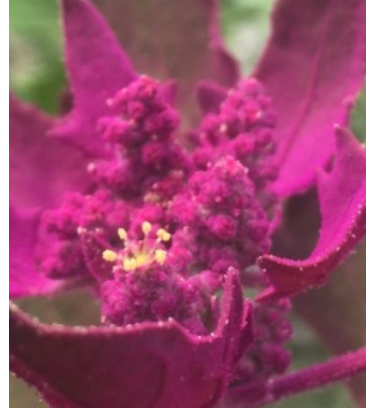


57



59

- Flowers still enclosed



60

- First extruded anthers

BBCH scale examples



67

- Anther dehiscence



69

- Senesced anthers



70

- Ovary thickening

Diseases



a



b

a) Leaves of wild-growing *Chenopodium* plants showing symptoms corresponding to the presence of complex pathogen infections.

b) An infected plant with primarily downy mildew disease.



Diseases – lesions on leaf surface



a

b

c

d

Lesions on leaf surface: a) pale or yellow chlorotic lesions with or without a halo and occasional pink-orange discoloration caused by a complex of leaf pathogens, b) bronze irregular lesions caused by *Alternaria* sp., c) diffuse chlorotic spots caused by *P. variabilis* and d) concentric and chlorotic halo under artificial inoculation with *Alternaria* sp.



Diseases – sporulation on abaxial leaf surface



a

b

c

Black dots showing downy mildew sporangia

Dark grey-violaceous sporulation caused by downy mildew (*Peronospora variabilis*)

Vein discoloration, general chlorosis and pink-orange spots caused by *Fusarium* sp. (Colque-Little, 2020)



Diseases – lesion type



a

b

c

d

Lesion type on upper surfaces and amount of disease ranging from a) dots, b) dots expanding, c) diffuse, and d) extensive (Colque-Little et al, 2021)



Diseases – scoring for area covered



1 = 0%–10%



2 = 11%–25%



3 = 26%–50%



4 = 51%–70%



5 = 71%–100%

Severity phenotyping scale 1-5 used for assessing the percentage of the leaf area affected. Leaf examples given represent different degrees of disease severity during the infection of *Alternaria* sp. on quinoa leaves



Examples for stem diseases



Quinoa black stem caused by *Ascochyta caulina* with the presence of dark structures (pycnidia) (Yin et al., (2020))



Pink stem and light pink mycelia corresponding to *Fusarium* sp. (Colque-Little et al., (2020))



Examples for panicle diseases



a

A panicle infected with *Alternaria* sp.



b

A panicle predominantly infected with *Cladosporium* sp. at the end of the season.

(Photos by Colque-Little 2020)