

Quinoa Phenotyping Cards

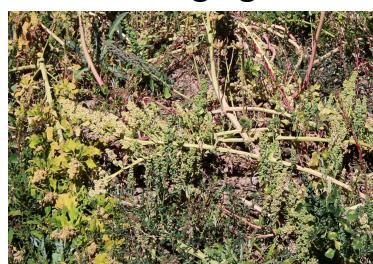
Stanschewski/Fiene 2021



Snapping



Lodging



Seeds



Percentage of the plot affected

1- up to 20%

3 ~ 30% (20% – 40%)

5 ~ 50% (40% – 60%)

7 ~ 70% (60% – 80%)

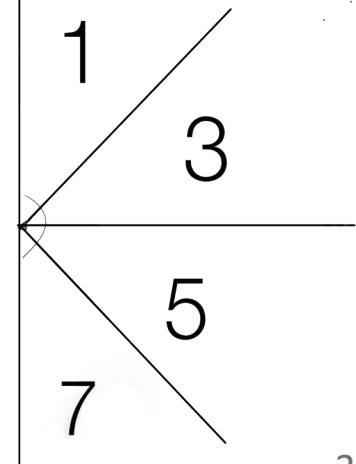
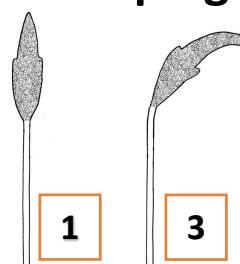
9 - over 80 %

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Panicle drooping

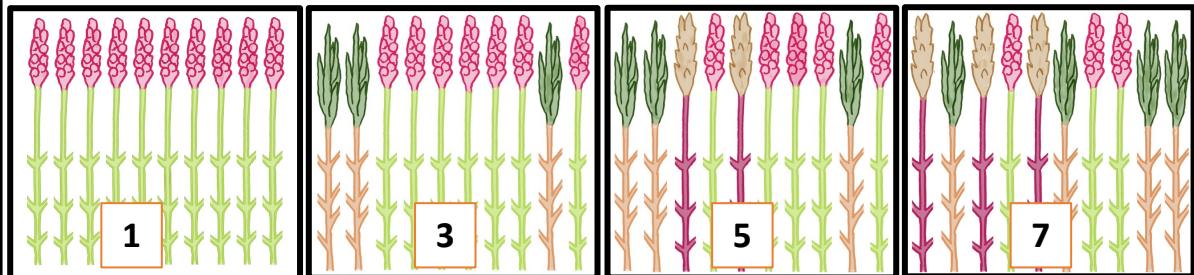


- 1 < 45°
- 3 < 90°
- 5 < 135°
- 7 < 180°



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Heterogeneity



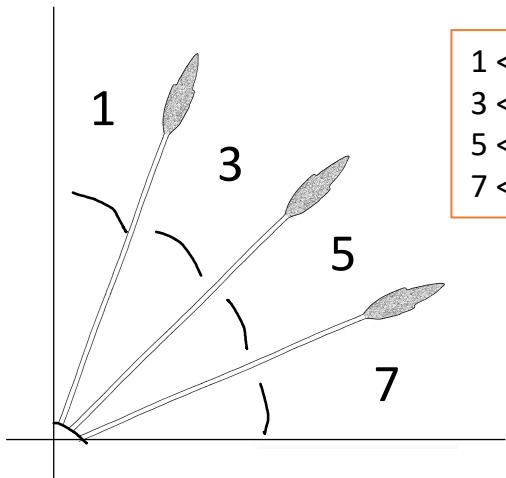
Most plants are the same (up to 10% different)

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)

Stem vertical angle



$1 < 22.5^\circ$
 $3 < 45^\circ$
 $5 < 67.5^\circ$
 $7 < 90^\circ$



Erectness of the stems of the majority of the plot:

1 = "soldiers" to

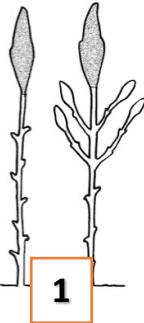
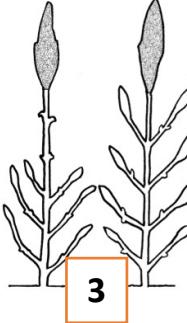
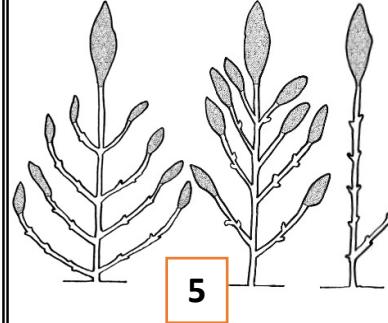
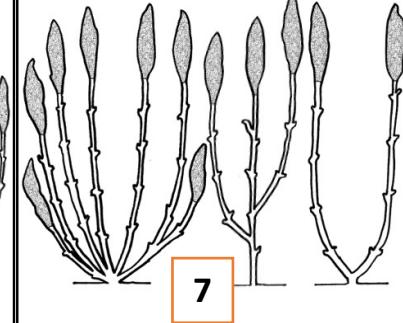
7 = plants are severely lodged and on or near the ground

Branchiness

Branches along the entire stem of the plant are assessed

- 1** No branches, or very short and spindly lateral branches
- 3** Few lateral branches, without significant panicles
- 5** Branches are more numerous and thicker, containing panicles that would be harvested
- 7** Numerous long and thick branches containing significant panicles

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

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Panicle colour

			
Green	13	Pink / Purple / Red	4
			
Green with Purple	16	Orange / Yellow	5
		Dark coloured	7

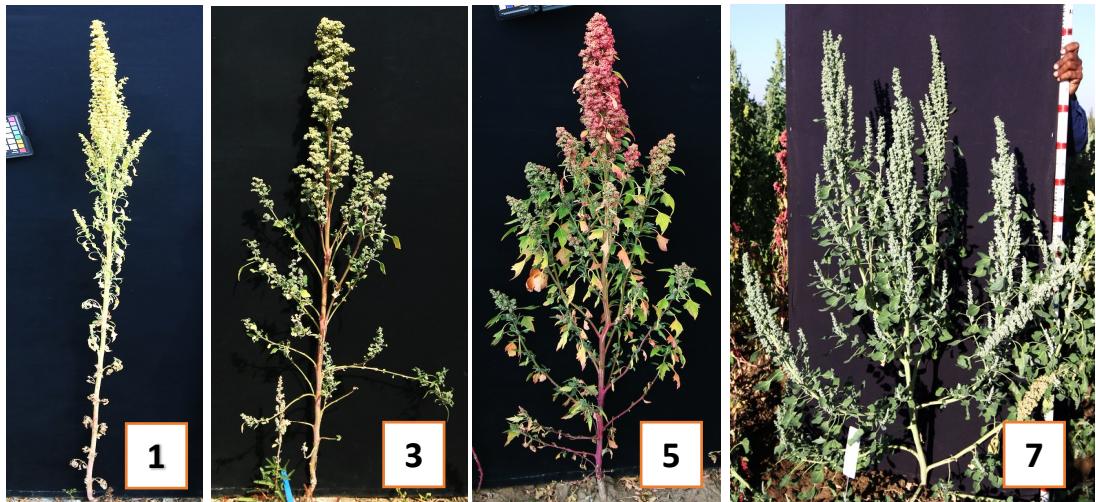
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Panicle shape

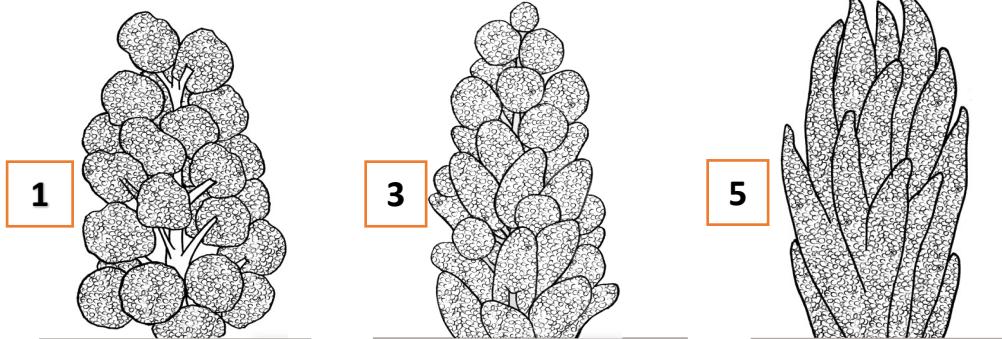


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Growth habit examples



Panicle shape



Glomerulate:
glomerules with
globose shape—
“bulbous clusters”

Intermediate: panicles
express both
amarantiform and
glomerulate traits

Amarantiform:
glomerules with
elongated shape –
“fingers”

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


1

3

5

7
7


Stem leaf shape


Rhomboidal (1)

Triangular (2)

Stem leaf margin


Entire (1)

Dentate (3)

Serrate (5)
8


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

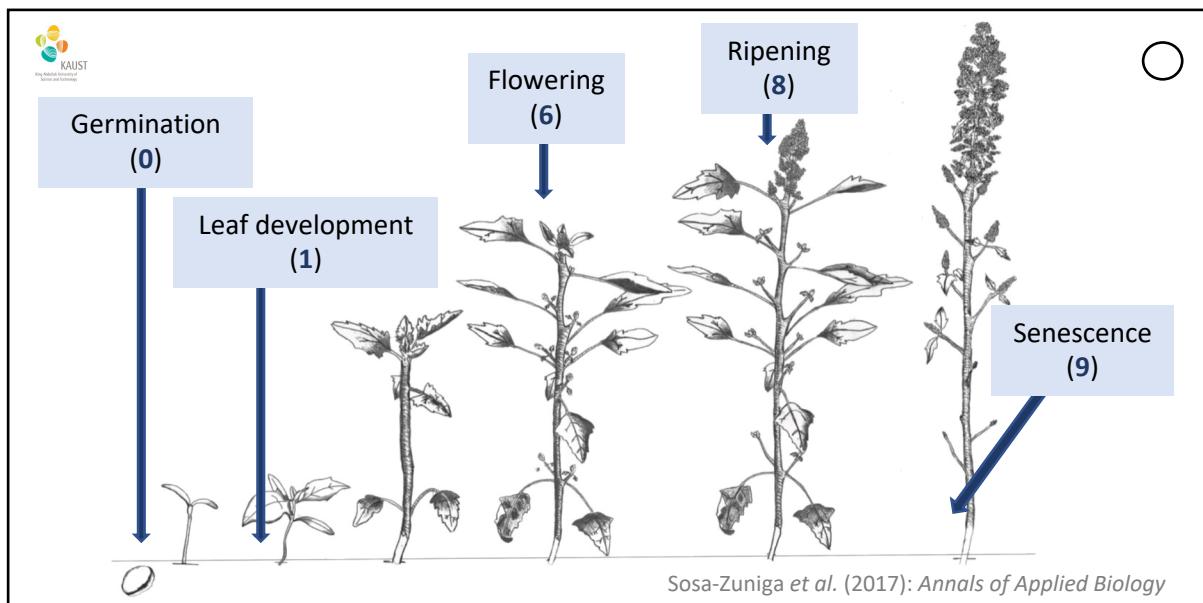
- 20 Visible lateral buds or expanded leaves without lateral stems
- 21 One side shoot visible
- 22 Two side shoots visible
- 29 Nine side shoots visible. If required, coding can continue following the same scheme.

Principal growth stage 3: stem elongation (omitted)

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

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Panicle leafiness



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

10



BBCH scale examples



67

- Anther dehiscence



69

- Senesced anthers



70

- Ovary thickening

11



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.

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BBCH scale examples



57



59

- Flowers still enclosed



60

- First extruded anthers

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 – sporulation on abaxial leaf surface



a

Black dots showing downy mildew sporangia



b

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

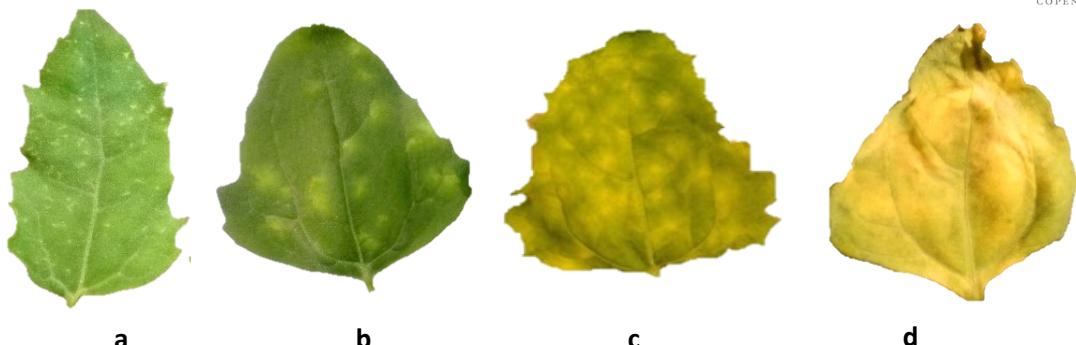


c

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)

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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))

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For more detailed descriptions, find our quinoa phenotyping paper at the following link

and reach out to us if you have any questions



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 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)

