Study of factors influencing the germination of *Apera spica-venti* (L.) P. Beauv. in controlled conditions

W. R. Meza Morales[1], C. Vanbellinghen[2], B. Bodson[1], F. Henriet[3]

[1] Unit of Crop management, Gembloux Agro-Bio Tech, University of Liège, Gembloux, Belgium

[2] Seed Testing Laboratory, Public Service of Wallonia, Gembloux, Belgium

[3] Plant Protection and Ecotoxicology Unit, Walloon Agricultural Research Center, Gembloux, Belgium

Abstract

Apera spica-venti (L.) P. Beauv., also said " silky bent grass" or "windgrass", is a common weed of cereal crops, especially of winter wheat. It is widely spread in Northern and Easthern Europe, Northern Asia, Siberia and Canada. The main problem is the competition for water, light, space and nutriment's elements between this weed and the cereal crop. This could involve important yield losses, sometimes reaching 30% ([1]Massa, 2011 ; [2]Warwick et al., 1985).

Given the ability of *Apera spica-venti* to grow and develop in cereal fields in Wallonia and the lack of scientific knowledge about its biology, 2 germination tests were performed.

- a preliminary test in order to know the germination percentage of 37 populations and to chose 4 populations among these.
- the main test in order to study three major factors influencing the germination of seeds: composition of the water solution, presence or absence of pre-chilling and temperature setup. This test was carried on according to the standards of the International Seed Testing Association (ISTA).

Germination tests showed that a solution containing 2 g/L of KNO_3 and alternating temperature between night and day from 10°C and 30°C favorably influence the germination of *Apera spica-venti*. These results in controlled conditions are a premise for greenhouse and field tests.

Preliminary test

Methodology

37 seeds samples (populations) were collected in different cereal fields in Wallonia during July 2011 and were submitted the preliminary test to assess their germination rate.

100 seeds of each population were deposed on filter paper in 2 Petri dishes and then moistened with 7 mL of distilled water. Then, these dishes were put in a germination room in the following conditions : temperature 17°C⇔10°C and photoperiod 14 hours of daylight and 10 hours of darkness. After 15 days, the germinated seeds were counted.

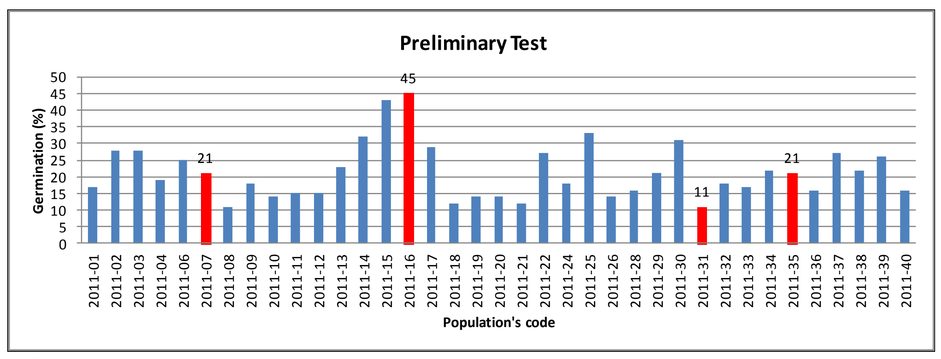


Figure 1 : Results of the preliminary test of germination, with in red the populations chose for the main test.

Results–Discussion

The figure 1 shows germination rates. The germination rates are heterogeneous and relatively low: all germination rates are between 11 and 45.

The heterogeneousness could be explained by the different provenance of seeds. These low rates could be due to seed dormancy.

Main test

Methodology

According to results of the preliminary test, 4 populations (in red in the figure 1) were selected to submit the main test respecting the standards of the International Seed Testing Association:

- the population with the greatest germination rate
- the population with the lowest germination rate
- and two populations with a middle germination rate

The main test was realised in Seed Testing Laboratory (Public Service of Wallonia) in May 2012.

3 factors were studied (table 1):

- temperature with 3 factor's levels:10⇔30°C, 20⇔30°C and 15⇔25°C
- solution with 2 factor's levels: with KNO_3 (2g/L), without KNO_3
- pre-chilling at 6°C during 7 days with 2 factor's levels : yes and no

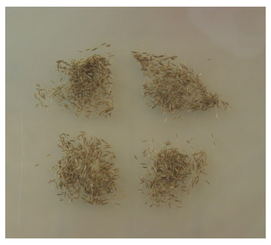


Table 1 : Factors and levels factors studied for the main test chose for the main test.

Factors	Factors levels
Temperature	20°C⇔30°C 15°C⇔25°C 10°C⇔30°C
Solution	N°1 (without KNO_3) N°2 (with KNO_3)
Pre-chilling	Yes No

Germination of a seed in an ISTA test is the emergence and development of the seedling to a stage where the aspect of its essential structures indicate whether or not it is able to develop further into a satisfactory plant under favourable conditions in the field (International rules for seeds testing chapter 5, 2011).

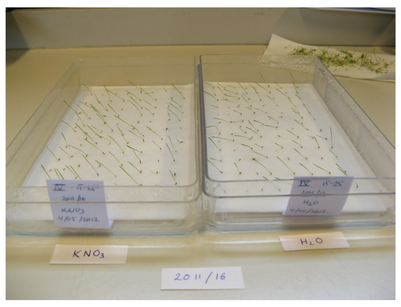
Setting up the germination boxes :

- after having mixed seeds, 0.5 g was taken for each population
- with a microscope, impurities (small stones, seeds of other plants, seeds empty) were remove from the sample
- for each factor's levels, 4 transparent boxes were made with 2 layers of paper. Each box received 100 seeds and 40 mL of solution.

The photoperiod was of 16 hours darkness and 8 hours daylight.

The test duration was 21 days.

The results were analysed with ANOVA in *Minitab 15* and the *Gupta method* was used to determine the factor(s) influencing the most the germination.



Results–Discussion

The germination rates are different in function of factors levels. The best germination rate is 84% and none population obtain a germination rate of 100% (table 2).

Moreover, each population had a different rate of germination for the same treatment.

Table 2 : Germination results (%) of the main test in function of all factors

Temperature	Pre-chilling	Solution	Pop. 1 2011-07	Pop. 2 2011-16	Pop. 3 2011-31	Pop. 4 2011-35
10⇔30°	No	Sol. n°1	75	82	65	70
		Sol. n°2	80	81	74	83
	Yes	Sol. n°1	56	70	49	58
		Sol. n°2	79	81	67	74
15⇔25°	No	Sol. n°1	50	67	45	51
		Sol. n°2	76	81	62	74
	Yes	Sol. n°1	41	64	37	37
		Sol. n°2	71	84	55	71
20⇔30°	No	Sol. n°1	64	74	53	73
		Sol. n°2	59	74	57	49
	Yes	Sol. n°1	34	59	39	38
		Sol. n°2	59	71	47	64

The analysis' method ANOVA shows that the germination of 2 populations is influenced of the interactions between factors, whereas the germination of the 2 other populations isn't.

Populations 2011-07 and 2011-35 are modified by interactions between factors

=> Analysis of the 3 factors concatenated

The values Gupta are 71 and 73 for the populations 2011-07 and 2011-35 respectively . The results in yellow in the figure 2 show the interactions factors giving the best germination rates.

Population 2011-07

Level	N	Mean
10-30°N°1Non	4	74,750
10-30°N°1Oui	4	56,250
10-30°N°2Non	4	80,250
10-30°N°2Oui	4	79,250
15-25°N°1Non	4	49,750
15-25°N°1Oui	4	40,500
15-25°N°2Non	4	76,000
15-25°N°2Oui	4	71,000
20-30°N°1Non	4	64,250
20-30°N°1Oui	4	33,500
20-30°N°2Non	4	58,750
20-30°N°2Oui	4	59,250

Population 2011-35

Level	N	Mean
10-30°N°1Non	4	70,000
10-30°N°1Oui	4	58,250
10-30°N°2Non	4	82,500
10-30°N°2Oui	4	74,000
15-25°N°1Non	4	50,750
15-25°N°1Oui	4	36,500
15-25°N°2Non	4	73,750
15-25°N°2Oui	4	70,750
20-30°N°1Non	4	72,500
20-30°N°1Oui	4	37,500
20-30°N°2Non	4	49,000
20-30°N°2Oui	4	63,750

Figure 2 : Results of germination rate for each interactions between factors

The environment characteristics producing the highest germination rate in both populations are :

Temperature (10⇔30°C) - Solution (with KNO_3)- Pre-chilling (No)
Temperature (10⇔30°C) - Solution (with KNO_3)- Pre-chilling (Yes)
Temperature (15⇔25°C) - Solution (with KNO_3)- Pre-chilling (No)

Populations 2011-16 and 2011-31 aren't modified by interactions between factors

=> Analysis of the 3 factors independently of each other

For the population 2011-16, the values Gupta are 69, 72 and 69 for temperature, solution and pre-chilling respectively. The best germination rates are underlined in yellow (figure 3).

Temperature			Solution			Pre-chilling		
Level	N	Mean	Level	N	Mean	Level	N	Mean
10-30°	16	78,375	N°1	24	69,125	Non	24	76,583
15-25°	16	73,813	N°2	24	78,625	Oui	24	71,167
20-30°	16	69,438						

Figure 3 : Results of germination rate for the population 2011-16 in function of each factor

And the values Gupta for the population 2011-31 are 57, 51 and 50 for temperature, solution and pre-chilling respectively (figure 4).

Temperature			Solution			Pre-chilling		
Level	N	Mean	Level	N	Mean	Level	N	Mean
10-30°	16	63,938	N°1	24	48,00	Non	24	59,25
15-25°	16	49,500	N°2	24	60,08	Oui	24	48,83
20-30°	16	48,688						

Figure 4 : Results of germination rate for the population 2011-31 in function of each factor

The factor levels yielding the highest germination rate in both populations are:

Temperature = > 10⇔30°C
Solution => With KNO_3
Pre-chilling => No

Conclusions

As far as germination tests are concerned, the optimal factors levels favoring *Apera spica-venti* (L.) P. Beauv. germination are a 10⇔30°C temperature and the presence of KNO_3 in the germination solution. None of the pre-chilling factor levels proved superior to the other. These results in controlled conditions are a premise for greenhouse and field tests.

The results of these germination tests are very important to gain time to perform other tests and experiments. For example, seed dormancy mechanisms' tests, resistance test, test to know the physiology better, test on the speed of growing, etc. As germination of *Apera spica-venti* (L.) P. Beauv. is now improved in controlled conditions, we hope it can help other scientists to study further aspects of this species.

[1] Massa D., 2011. *Investigations on herbicide resistance in Apera spica-venti populations.* Dissertation: Faculty of Agricultural Sciences, University of Hohenheim (Germany).

[2] Warwick S.I., Black L.D. & Zilkey B.F., 1985. Biology of canadian weeds: 72 *Apera spica-venti*. *Can. J. Plant Sci.*, **65**(3), 711-721.