

Variation in Seed Germination of Cultivated and Weedy *Perilla* (*Perilla frutescens* var. *frutescens*)

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Abstract: Seed germination was investigated in four populations of *Perilla* (*Perilla frutescens* var. *frutescens*) collected in Nagano, Japan. One of the four grew as a weed in a plum orchard, and the other three were cultivated by different practices. Seeds obtained from the four populations were sown on May 21, 1993, and mature seeds were harvested from raised plants from October 1 to November 1 of that year. The seeds of each population were divided into two groups. One was stored at a constant 5 °C, and the other was stored at an alternate temperature. The germination of one hundred seeds in each population of both groups kept at 25 °C was recorded at intervals of one month with three replications. The germination of freshly harvested seeds was investigated with three replications.

The germination percentage of each population increased with longer storage and was higher in the seeds stored under an alternate temperature than those stored under a constant 5 °C. Freshly harvested seeds and those stored for less than two months in weedy perilla (No. 25 population) did not germinate, whereas 14 % of the freshly harvested seeds

germinated in no. 11 population, which was assumed to be the most domesticated type. After two months of storage under an alternate temperature, 80 % of the seeds of no. 11 population germinated. The other two populations showed an intermediate pattern of germination between the no. 11 and 25 populations. The differences in the seed germination pattern seemed to be due to the differences in the degree of domestication.

Key words: abandoned crop, germination, *Perilla frutescens* var. *frutescens*.

Introduction

Perilla (*Perilla frutescens* Britt. var. *frutescens*), "Egoma" in Japanese, is an oilseed and vegetable crop cultivated in Asia. In Japan, this crop has been widely cultivated as oilseed, and its production amount decreased rapidly with the introduction of rape and sesame⁷⁾. The crop is extensively grown in Nagano Prefecture and there are many landraces. The cultivation practices of this crop vary: Its abandoned plants sometimes grow as weeds in orchards and around kitchen gardens, and their seeds are also harvested and utilized⁸⁾. This offers a good example for understanding the relationship between crop and weed.

A high level of seed dormancy is a characteristic of weeds¹⁾, and seed dormancy is one of the features differing between crops and weeds. Most crops have adapted to the conditions of planting and harvesting the seeds, and as a consequence of automatic selection

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they have reduced or lost their seed dormancy. Weeds, on the other hand, do not need man's help to reproduce and establish their populations^{3,4}, and hence it is very important for them to germinate in the proper season to complete their life cycle. Are the germination characteristics of weedy perilla different from those of the cultivated plant? How does the weedy perilla persist in fields? To answer these questions, the germination patterns of weedy perilla were compared with those of perillas cultivated under different practices, and the impact of man on the germination characteristics were discussed.

Materials and Methods

In 1991 and 1992, 122 perilla seed samples were collected from 96 farmers in Nagano, Japan, and the cultivation practice utilized by each farmer was recorded through interviews. We designate here a seed sample as one population. For the germination test, one weedy population and three populations subjected to different cultivation practices were chosen from the above 122 populations (Table 1). Number 25 population is a weed in a plum orchard and the others are cultivated populations. Among the cultivated perilla, the no. 11 population was most carefully grown.

On May 21, 1993, seeds of the four populations were sown, and 20 seedlings per population were transplanted on June 7 of that year in the field of the experimental farm of the

Faculty of Agriculture, Shinshu University at a spacing of 1×0.7 m. Seedlings of each population were planted in conditions isolated from the others. Fertilizers (N; 36, P₂O₅; 36, K₂O; 29 kg/ha) were applied as basal dressing. Cultivation was done following the standard practice in Nagano Prefecture. Seeds of each population were harvested between October 1 and November 1.

The germination of freshly harvested seeds was tested. One-hundred seeds of each population were placed on moist filter paper in a 9 cm diameter glass petri dish, and were incubated at 25 °C for two weeks. Germination was monitored daily, and germinated seeds were removed when radicles emerged. Three replications were made of each germination test and the data were compiled.

Harvested seeds of each population were divided into two groups, one was stored at a constant temperature of 5 °C, and the other was stored in an outside shed. The four sides of the shed were left open throughout the study, and temperature was not controlled; temperature fluctuation in the shed during the study is shown in Fig 1. Germination tests were made as described above at monthly intervals from the first to eighth month after harvest.

Results and Discussion

Germination patterns of the four populations stored at a 5 °C constant temperature

Table 1. Cultivation practices of four perilla populations

Population No.	Collection location	Cultivation practices
11	Mochizuki, Nagano	In the collection site, both early and late maturing types were cultivated. Manure was applied.
15	Fujimi, Nagano	Direct sowing and seedlings were thinned.
20	Tatsuno, Nagano	Direct sowing and minimum fertilizer was applied.
25	Tenryu, Nagano	Growing as a weed in a plum orchard and seeds were harvested.

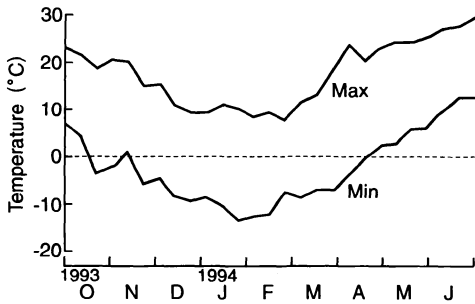


Fig. 1 Seasonal change of maximum and minimum temperature in the shed during the study.

are shown in Fig. 2 and under an alternate temperature in Fig. 3, respectively. Freshly harvested seeds of the tested populations other than no. 11 germinated little or not at

all, but the germination percentage of the seeds of no. 11 population reached 14 % after a two week incubation.

As the stored period lengthened, the seeds germinated more quickly and simultaneously, and the germination percentages after a two week incubation were generally higher, although the percentages after eight months of storage were lower than the others. Many farmers stated that perilla seeds lost their germinability after one season of storage following harvest. The results of this experiment confirmed those statements. The decrease in germination percentage after eight months of storage may not be due to the secondary dormancy of seeds, but to their death. Germination percentages were higher in the seeds stored at alternate temperatures

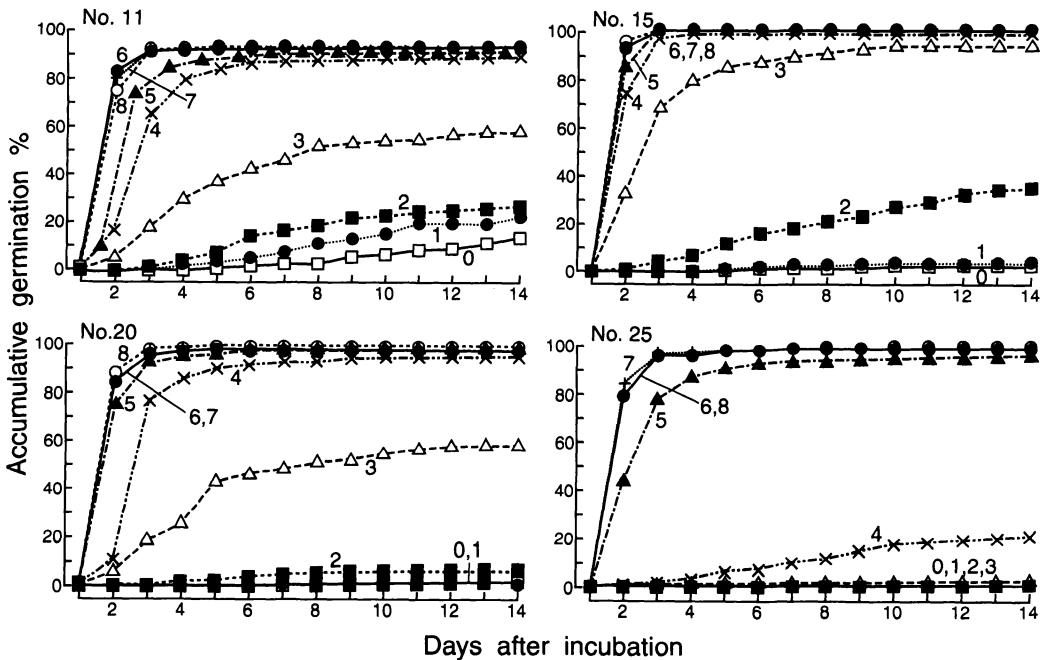


Fig. 2 Germination patterns of seeds of the four perilla populations stored at 5 °C.

Numbers in the figure indicate period of storage (months).

—□— ; zero (freshly harvested seed) ●●●● ; one ■■■■ ; two ▲▲▲▲ ; three
 —×— ; four —▲— ; five —●— ; six —+— ; seven —○— ; eight

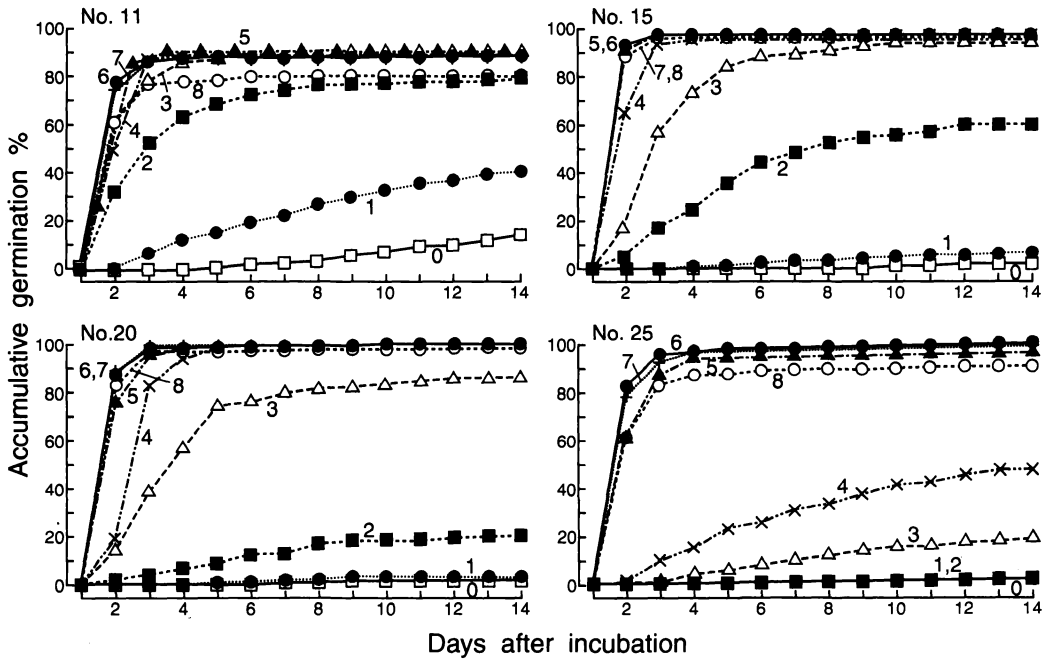


Fig. 3 Germination patterns of seeds of the four perilla populations stored under an alternate temperature. Numbers in the figure indicate period of storage (months).
 —□— ; zero (freshly harvested seed) ●—●— ; one —■— ; two —△— ; three
 —×— ; four —▲— ; five —●— ; six —+— ; seven —○— ; eight

than in those stored at a constant 5 °C. The result shows that the dormancy of perilla seeds is gradually broken as time goes by after harvest and that an alternate temperature is more effective in breaking dormancy than a constant 5 °C.

There was a wide variation in the germination pattern among populations as well as plant size, morphology and life history traits⁹⁾. The seeds of no. 25 population took longest to germinate and were the most dormant. No germination was found in periods of less than two months storage under either storage condition. After three months, 18 % of the seeds stored at an alternate temperature germinated, but only a few of those stored at a constant 5 °C germinated. The germination percentages of this population

increased abruptly after five months of storage, and almost all seeds germinated. To break their dormancy, perilla seeds need to suffer a low temperature for several months, as is known in many summer weed species²⁾. This population grew as a weed in a plum orchard, therefore deep seed dormancy is assumed to be indispensable to avoid germinating in fall, and quick germination in spring may be advantageous to compete with other species. This germination characteristic may allow establishment of the population and completion of the life cycle. Since wild perilla does not occur in Japan and its weed form was not found around the area observed, this no. 25 population might have originated from abandoned perilla. A perilla plant can have seeds with different degrees of

dormancy, and natural selection seems to lead toward a greater number of dormant seeds. This germination pattern is selectively advantageous in a weed habitat.

Fourteen percent of the freshly harvested seeds of no. 11 population germinated within two weeks after harvest, and showed the highest germination percentage among the tested populations in seeds stored for one and two months under different conditions. The high germination percentages were especially conspicuous in seeds stored under an alternate temperature. After one month storage, germination reached 41 %, and after two months it reached 80 %. Almost all seeds germinated after five months of storage except those stored for eight months. As reviewed by de Wet and Harlan³⁾ and Harlan et al.⁴⁾, sowing increases seedling competition because of an increase in population density, and seedlings that germinate as soon as conditions are favorable adapt well in a sown field, hence seeds that do not germinate soon after sowing will not contribute to the harvest. The germination characteristics of no. 11 population seemed adaptive to sowing.

In the area where no. 11 population was collected, both early and late maturing types of perilla were extensively cultivated, and the farmer grew the crop very carefully; this population was the early maturing type with low height and had the heaviest seed⁹⁾. Thus, it is assumed that no. 11 population is the most domesticated perilla among those tested.

The other two populations showed patterns of germination intermediate between no. 11 and 25 populations. Their seeds were directly sown in fields (Table 1); in one population seedlings were thinned, and in the other minimum fertilizer was applied. The cultivation practices applied to the two populations differed, and also the "care" given to the

cultivation by the farmers was different. These differences in cultivation practice and care may be responsible for the continuous variation in the germination pattern of the crop.

Farmers have been raising their own "varieties", whereas weedy perilla has persisted in fields. Man has automatically selected less dormant seeds through the domestication of wild plant species³⁻⁵⁾. Abandoned perilla has not undergone artificial selection such as sowing and might have achieved even deeper dormancy by natural selection. Perilla is predominantly a self-pollinated species⁹⁾. The germination characteristics of each population may have easily differentiated under different cultivation practices and natural selection.

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栽培および雑草エゴマの種子発芽における変異

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摘 要

エゴマは古くから油料作物として栽培されてきたが、一部が逸出し、畑の周縁などで雑草として生育している。長野県内で収集した雑草型のエゴマ1集団と栽培方法の異なるエゴマ3集団 (Table 1) の発芽特性を比較した。

1993年5月に各集団の種子を播種し、10月から11

月にかけて収穫した。収穫した種子を5°C貯蔵群、変温 (Fig. 1) 貯蔵群の2群に分け、1ヵ月ごとに25°C恒温条件下で発芽を調査した。とりまき種子の発芽も調査した。発芽試験は100粒×3反復で行った。

一般に貯蔵期間が長くなるほど、また、変温条件下で貯蔵した種子の方が発芽率が高かった。雑草エゴマでは、貯蔵期間が2ヵ月以内では発芽がまったく認められなかったが、最も栽培化が進んでいると推定された集団では、とりまき種子で14%が、2ヵ月間変温条件下で貯蔵した種子では80%が発芽した (Figs. 2, 3)。他の2集団は両者の中間の値を示した。エゴマの発芽率における変異は、栽培化の程度に対応していると推定された。

キーワード：逸出作物、エゴマ、発芽

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