SOME ASPECTS OF THE BIOLOGY OF RASPWEED (*HALORAGIS ASPERA*)

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Summary. The objectives, details and results of four germination experiments on the fruit of raspweed are reported. Effects of gibberellic acid, scarification, temperature, light and previous storage regimes on germination and dormancy are highlighted. Results are discussed and field implications are drawn. The importance of raspweed's sexual reproductive strategies as compared to its asexual strategies is noted. A brief indication of raspweed's weediness is also provided.

INTRODUCTION

Raspweed, *Haloragis aspera,* is a member of the Haloragaceae family. It is a native of Australia where it is widely distributed but limited to south of the Tropic of Capricorn. Isolated incidences have been reported in Western Australia and Tasmania. Raspweed is a major perennial weed of cultivation in central Queensland, parts of southern Queensland and north-western New South Wales.

Raspweed it is often referred to as a 'take-all' weed because where it grows nothing else will. Its extensive root system and non-seasonality attribute to its weediness. Little is known about the biology of raspweed and hence management is often difficult. It is a perennial herb up to 30 cm high with annual stems arising from a deep subterranean system. Leaves are up to 4 cm long with hooked hairs giving a raspy texture, hence its common name. The inflorescence is an indeterminate spike of dichasia of 3 to 5 very small flowers. Fruits are small, globular with persistent sepals. The woody exocarp encloses four locules with the potential for all locules to be filled with one pendulous ovule (2). The contribution made by sexual reproduction to the population dynamics of this weed is not fully understood, and while it is not considered the major path of reproduction, the plant devotes much energy toward it (Osten, unpublished data).

Information on the different components of reproductive strategy is necessary for the development of efficient integrated management programs (1). This paper reports on aspects of raspweed's sexual reproduction, emphasising the requirements for germination.

METHODS

During spring 1990 mature fruits were collected from potted raspweed specimens grown in central Queensland. Half of the collection was stored in air tight containers at -5°C for a period of 20 months. The remainder was after-ripened at a constant 25°C for up to 30 months.

Several unsuccessful attempts were made to remove the gel-like seeds from the woody pericarp of the fruit without causing damage to the embryos. Consequently, all germination studies have used the entire fruit capsule.

Four germination experiments were conducted in controlled environment growth cabinets. The first two were undertaken at The University of Queensland in late 1990 and early 1992. The

latter two in Emerald in mid 1992 and early 1993. Germination was monitored for six (Experiments 1, 2, 3) or ten (Experiment 4) weeks.

Experiment 1. The objectives were to determine whether freshly collected raspweed fruits have the ability to germinate, the requirements for such and whether the fruits exhibit dormancy. Treatments included a combination of two scarification regimes (scarified and not); four gibberellic acid (GA) concentrations (nil, 0.1, 1.0 and 10.0 mM); three temperature regimes (15, 20 and 25°C) and two light regimes (light and dark). Scarification involved removing the blossom end of the fruits with a sharp scalpel. Darkness was imposed by wrapping dishes with alfoil. The nil GA solution used sterile water.

Experiment 2. The objective was to determine and compare the germination ability of fruits which had been stored at -5°C for 20 months and fruits which have been after-ripened at 25°C for the same period. Treatments were a combination of two light regimes (light and dark); three alternating temperature regimes (18/13, 25/20 and 30/20°C); two GA concentrations (nil and 1.0 mM) and two fruit types (stored -5°C and stored 25°C). All fruits irrespective of fruit type were scarified (as in Experiment 1).

Experiment 3. The objective was to determine the effect of light on the germination of fruit capsules with a longer after-ripening period (24 months at 25°C). Only two treatments were used in this instance (light and dark). All fruit were scarified and every dish had 1.0 mM GA added. All were kept at a constant 14°C.

Experiment 4. The objectives were to determine the germination ability of fruits kept for 30 months at 25°C (compared with previous experiments) and whether dormancy has been reduced such that scarification and GA are no longer necessary to facilitate germination. The treatments were a combination of two scarification types (scarified and not); two GA concentrations (nil and 1.0 mM) and two light regimes (light and dark). Scarification procedures were the same as Experiment 1. All dishes were kept at a constant 14°C.

RESULTS AND DISCUSSION

Experiment 1. Irrespective of treatment, it took at least 21 days for the first fruit to germinate. After six weeks, only 1.7% of the total 1440 fruit germinated. Referring to only that which germinated, and considering each treatment factor on its own, 52% germinated at 15°C, and 28% and 20% at 20 and 25°C respectively. 68% germinated in 1.0 mM GA and 16% in each of the 0.1 and 10.0 mM GA solutions. Of those germinated, 68% were scarified and 64% were in the light. The highest yielding treatments (combined factors) were equal between the 15°C with 1.0 mM GA + scarified + light, and its similar treatment in the dark. Collective data indicate that fresh fruit capsules have a high degree of dormancy. Some degree of dormancy can be broken by scarification and applications of GA. Germination requires cool temperatures and light.

Experiment 2. The first after-ripened fruit germinated only after seven days and the first 'cold' treated fruit after 14 days. Again only 1.5% of the total fruit germinated. Of those germinated, 86% were from the after-ripened batch. Irrespective of fruit type, light regime or GA, 41% germinated at 18/13°C, a further 41% at 25/20°C and 18% at 30/20°C. Considering the other treatment factors, 73% germinated in the presence of GA; and equal numbers germinated between the light and the dark. The highest yielding treatment was the after-ripened fruit kept at

18/13°C in the light with the GA. Considering that all fruit were scarified and the overall low germination, dormancy must still be playing an important role. Only 2.6% of the total after-ripened sample germinated compared with <0.5% of the 'cold' treated sample.

Experiment 3. Following after-ripening for 24 months, germination increased to 29%, equally in the light and in the dark. Again all fruit were scarified, all had GA applied and all were kept at 14°C. Sixteen days after treatment, 31 fruit had germinated with 65% of these in the dark. Later germinations preferred the light. It appears that dormancy has been reduced to some extent and this is reflected in the increase in overall germination (increase from 2.6% to 29%) even though scarification and GA have been used as facilitators.

Experiment 4. It took 12 days until the first fruit germinated and by 70 days 7% had sprouted. Considering treatment factors on their own and only those that germinated, 93% had 1.0 mM GA added; 80% were in the light and 64% were scarified. The combination of GA and light yielded 73% of the germinated fruit. The treatments containing GA, light and scarified fruit produced 48% of the germinated fruit and the similar treatment with the unscarified fruit produced 25% of the total. These data indicate that after 30 months of storage at 25°C, raspweed fruits still exhibit a high degree of dormancy. The overall germination percentage was still low but has increased over that achieved in Experiments 1 and 2. In this experiment the application of GA was the major facilitator of germination. While scarification assisted, its affects across treatments were not as obvious. In this instance germination appeared to be influenced by light.

Implications. Field germination of raspweed is likely to be very low, probably as low as 1% for the fruit/seed bank. Fruits in the field are not kept in constant conditions and do not have growth promotants like GA freely available, nor are they readily scarified. It is obvious that raspweed fruits exhibit a very high degree of dormancy and or low viability. Viability has not been addressed and can not be ignored. Scarification to remove part of the woody pericarp may have enhanced germination but not to a great extent. This suggests that (a) some other non-mechanical agent is controlling dormancy and or (b) the seeds have low viability. The woody pericarp may not be a major barrier to germination. The assumption can be made that under field conditions the woody pericarp will eventually decay and with cool conditions the fruit will germinate on the soil surface and from depth. While light would not appear to be a major factor, preference for light conditions has been exhibited.

Cool temperatures around 15°C are much preferred for germination. In central Queensland, this would mean germination is restricted to the cooler winter months, but in southern regions, the germination window would be much wider. This temperature requirement may explain the limit of the species northern distribution. In central Queensland winter rains are quite rare so optimal conditions for germination are not likely to be experienced as often as they would in southern regions. However, raspweed is still a major problem in central Queensland, its weediness attributed more to its asexual reproductive traits.

Clearly, reproduction from seed is not raspweed's primary method of proliferation, but the plant devotes much energy toward it. This biological function must occur for a purpose. Maintenance of genetic variability, assurance of long term survival of the species and wider dispersal are the probable reasons. While raspweed's sexual reproductive strategies may not be as important as the asexual methods, they can not be disregarded when considering weed management techniques. Allowing the seed bank to replenish and build up, even if only 1% generate new

plants, these new plants are then a potential problem considering the contribution they will make using their asexual reproductive strategies.

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