CULTIVATING AND HARVESTING *PHALARIS* GRASS FOR OPTIMUM ALKALOID PRODUCTION

by K. TROUT

Adapted from TROUT'S NOTES A-5 *Ayahuasca and Ayahuasca Alkaloids*
Please consult these NOTES for a more detailed discussion. See advertisement on page 65.

Phalaris can be easily grown but like any grass, care must be taken not to disturb newly germinating plants or damage their roots. Surface sow, then gently water it in and mist or gently sprinkle regularly until it comes up. If misting is not an option, try covering the soil surface with fibrous mesh such as are sold for retaining grass-seeds and lightly but frequently water with a sprinkler. Once the plants are established water normally. It will do best when in the ground but large flat containers (like kiddie wading pools with drain holes added) work fine for a couple of years. It can also be started in flats or pots and then transplanted. While many strains of *P. aquatica* love wet conditions, some are very drought tolerant. Since the AQ-1 was found in dry weathered caliche, this might suggest that it may do better if kept on the dry side. Plant the seeds in early fall or as early in spring as possible. (Many *Phalaris* show a summer dormancy period.) Before you plan to harvest, subject them to several months of moderate drought stress, then severely cut back the plants. Begin heavy watering. The regrowth that occurs is the best crop, followed by the second regrowth, which will be weaker. The sooner the plants are harvested the higher the alkaloid content but there is a trade-off as the volume is much less. While a week of growth may be more potent, a month of growth will yield more material. In the northern hemisphere, it appears that later summer into fall is the only time when the grass is very potent but we might add that the actual work done is fairly limited. It is clear that regardless of all other factors, there are one or more rather brief but very high peaks of tryptamine concentration occurring during this time period. The work-to-date suggests that ß-carbolines may be favored during other times of year when the alkaloid content is much lower. Another important factor is the occurrence of alkaloid subtypes within most populations of *Phalaris*. For this reason, in all but a few strains, it is preferable to obtain tried-and-true plants if possible and propagate them by rhizome divisions.

Many factors can affect alkaloid concentration and composition. The work involving *P. aquatica* has been inadequate for our discussion but we might better understand the situation if we approach *Phalaris* generically with an eye for determining what variables are important. Along with the part of the plant harvested and using regrowth instead of first growth, the best date for harvest is one of the most important factors to consider, despite the great difficulty of predicting it. Alkaloid concentrations and proportions are highly variable from week to week and also from year to year and usually show dramatic seasonal fluctuations (this is most pronounced in the high-alkaloid producers and varies markedly between strains). Additionally, fluctuations in the actual alkaloid composition itself have been noted. In many populations there may even be marked differences in both amounts and the actual alkaloid profile from one plant to the next. (Some strains are more true than others and it is these which tend to be selected for ayahuasca analogue use.) For these reasons it is impossible to give an exact prediction of when is best to harvest, but we can get it into the ballpark.

Some of the highlights to consider when growing *Phalaris* for use: Age and regrowth differences are extremely important. Not only is the alkaloid level highest in the new growth but artificially induced growth (regrowth following mowing or cutting) shows a consistent increase over the initial levels (BARNES *et al.* 1971; MARTEN *et al.* 1973; MOORE *et al.* 1967; PARMAR & BRINK 1976; WOODS & CLARK 1971). Second regrowth (following a second cutting) often shows an increase from the initial value but falls short of the concentration in the first regrowth. The initial growth shows the lowest concentrations and was apparently devoid of alkaloids in a few cases that had quite potent regrowth! One study of high-alkaloid strains (that contained mainly gramine) found that cutting every second week caused sharp increases over freely growing plants (WOODS & CLARK 1971). Age-related differ-

ences can be quite dramatic. Alkaloid content has been consistently noted to be highest in young growth, with tryptamine content dropping with age (MARTEN *et al.* 1973). 5-MeO-DMT concentration has been evaluated in new growth of *Phalaris tuberosa* leaves (cv. Hardinggrass) and was found to be 0.236% in 7-day-old fresh leaves, 0.105% in 9-day-old fresh leaves and 0.077% in 21-day-old fresh leaves. 21-day-old leaves that had been frozen for 3 days showed 0.076%. 21-day-old leaves that had been dried showed 0.071%. All figures are % dry weight (MCCOMB *et al.* 1969). *Phalaris* species have been reported to contain 65–81% water by weight. 80% is common in regrowth harvests.

Seasonal differences can be dramatic. Great variations of alkaloids have been found not only between different strains but also between sampling dates. The total tryptamine levels in 'Seedmaster' (DMT is main alkaloid) and 'Sirocco' (5-MeO-DMT is main alkaloid) were approximately five times greater in Autumn than in Winter (ORAM 1970). Autumn had higher temperatures, higher light intensities, longer days and more moisture stress. In one study of *Phalaris tuberosa* cv. *stenoptera* (Hardinggrass) the total indole alkaloid levels hit two peaks of 0.14% in late September and mid November one year but only one peak in each of two other years (RENDIG *et al.* 1970). In the latter cases; the year with a peak in late September was also around 0.14% while the year with the peak in mid-November was 0.08%. The latter year showed some of its lowest values in late September. This analysis only included data from mid-September through mid-February. In northern hemisphere studies, July through early August should be the starting point for such determinations. Especially in the northern US where peaks have been noted during this time. Alkaloid levels have also been reported as being markedly different from one month to the next and one year to the next. In some clones, there was also a change in alkaloid composition (MARTEN *et al.* 1973).

Diurnal differences have been reported. Foliage harvested early in the morning showed greater quantitative yields than if harvested later in the day (APPLESEED 1992–1996).

Temperature has effects on alkaloid production. Increased temperatures have been found to result in higher DMT and total alkaloid levels in all ecotypes of *P. aquatica* (as *P. tuberosa*) examined in one study (ORAM 1970). The highest alkaloid levels reported were seen in plants experiencing 21° C days, 16° C nights (MOORE *et al.* 1967). These plants also showed the greatest yield of plant weight (36.9 grams of dry weight per 18 plants.)

Moisture can also play a role. Moisture stress increases alkaloid levels, and the best quantitative results came when harvesting the new regrowth resulting from rains following a drought (MARTEN *et al.* 1973; APPLESEED 1992–1996).

Light levels can be an additional factor. Shading also increases alkaloid content but does so at the expense of plant growth and stimulates 5-MeO-DMT production far more than DMT content. (In strains that produce only DMT this is not an issue.) One study determined that 28% light intensity increased the alkaloid content dramatically—61%—but it also decreased the total yield of plant material dramatically—64% (MOORE *et al.* 1967). Artificial shading applied to growing *Phalaris* pasture swards, showed marked increases at between 40% and 12% light levels, a low and insignificant increase from 99% to 40% and a decline below 10% light level. Alkaloid levels were found to be high in shaded plants irrespective of nitrogen levels and did not increase in response to increased available nitrogen. In full light the alkaloid levels increased in direct proportion to the concentrations of nitrogen. 12% light levels caused 5-MeO-DMT to rise to a level of 50 mg per 100 grams of dry weight. At all other times DMT was the predominate alkaloid in the *Phalaris* studied (*P. tuberosa* cv. Australian Commercial). Decreasing the light intensity was also found to increase the alkaloid levels (FRELICH & MARTEN 1972).

Nutrition can have dramatic effects on alkaloids. One study found that *P. tuberosa* cv. Australian Commercial grown under high nitrogen conditions contained up to four times as much total alkaloid as those grown nearby in garden rows without added nitrogen (MOORE *et al.* 1967). Regrowth was taken three weeks after cutting to ground level and commencing nitrogen treatments. Similarly high alkaloid levels have been noted in fields enriched by several seasons of clover. An insignificant difference was found between low and intermediate nitrogen levels on alkaloid production, whereas at the high level a mean average in excess of over 20% increased total alkaloids was reported (MOORE *et al.* 1967). This was coupled with an increased dry weight for the sample. The highest levels of alkaloids were observed in the uppermost leaves of plants receiving ammonium sulfate at high rates (PARMAR & BRINK 1976). Generally speaking (at high levels): Ammonium sulfate > Ammonium nitrate > Urea > Cyanamid > Sodium nitrate in terms of benefiting alkaloids production (MARTEN *et al.* 1974). It is important to be aware that this is only true at high levels of high nitrogen fertilizer. And that there is minimal benefit if the amounts are low to moderate *or* if the plants are shaded *or* if a balanced fertilizer

if used. Nitrates favor vegetative growth (as does high K levels); Ammonium favors alkaloid production. Tryptamine concentrations seem to be related to both the type and the amount of fertilizer used (GALLAGHER 1966; FRELICH & MARTEN 1972). However, the picture may be more complicated as significantly higher levels of alkaloid in plants grown in an infertile peat soil than in fertile, mineral rich soil have been found (MARTEN *et al.* 1974). Addition of a complete fertilizer in some cases decreased the alkaloid levels when compared to sterile peat but their results were conflicting. Uptake of ammonium ions tends to be greater on glei soils than well drained types (PARMAR & BRINK 1976). *High levels* usually represent around five times the normal recommended nitrogen. This is well within what is often recommended for turf maintenance. Alkaloid distribution within the plant should also be considered. It has been determined that the upper third of the regrowth of *P. arundinacea* has the highest alkaloid concentration overall (HAGMAN *et al.* 1975). Slightly higher concentrations in field grown plants have been reported than those maintained in a greenhouse (HAGMAN *et al.* 1975). The following average alkaloid concentrations in *P. arundinacea*, using only regrowth and harvesting when the plants were at 20–60 cm tall and still in vegetative stage, have been reported: 0.29% in upper half of leaf blades; 0.23% in lower half of leaf blades; 0.07% in leaf sheaths; 0.04% in stems; 0.05% in inflorescences (MARTEN *et al.* 1973).

Drying (or freezing) versus fresh material. Around half of the total alkaloid has been reported lost during drying (CULVENOR 1964). In addition, there was a higher proportion of bufotenine and a lower proportion of the uncharacterized indoles of high Rf present in fresh grass. A similar decrease when comparing fresh material to frozen has been found by others (BARNES *et al.* 1971). Drying or freezing has the greatest negative impact on young growth and on high alkaloid strains. The effects on older growth and on poor alkaloid producers is much less. The response to drying has been found to be highly dependent on the variety (APPLESEED 1992–1996). While the total is less, some strains increase the 5-MeO-DMT to DMT ratio as they dry. Grass treated with ethanol immediately upon harvesting also gave higher returns. This is believed due to the action of the alcohol denaturing the enzymes responsible for the loss (CULVENOR 1964).

Optimum conditions for high-alkaloid harvest: Using the first regrowth after cutting, using only the upper third, harvesting in late summer to fall, early in the morning, using new growth following rains at the end of a prolonged dry spell and with ambient conditions of 70° F, or hotter, days and night-time temperatures in the 60s. The alkaloid concentration will be maximized in plants excessively fed with ammonium or else grown in shade. The exact peak dates appear to vary not only from strain-to-strain but thus far seem to also vary from year-to-year. Still, what has been published suggests that, in the northern latitudes, the peak(s) will occur at some point during early August to November, with the most likely peak dates occurring during the latter part of August to the end of September. While detailed studies on a day-by-day basis have never been performed, there appears to be an initial high peak on day 7 both in seedlings (MULVENA & SLAYTOR 1982, 1983) and in new growth after recutting (MCCOMB *et al.* 1969] In some studies it appeared that tryptamine concentrations showed huge spikes during early fall growth but none lasted more than a few days at most (ORAM 1970). Some strains showed decent concentrations at around 4–6 weeks of regrowth, so there may be a happy medium between trying to maximize the alkaloid concentrations and the volume of useful material (MARTEN *et al.* 1973). While it may be best to attempt to get the best volume of growth and catch a peak level of tryptamines, it would be interesting to study the home production of *Phalaris* grown (and processed) like wheatgrass with harvests performed on day 7. Obviously this will require raising a seed-crop to obtain adequate seeds to make this cost effective.

While *Phalaris* may be highly variable in content and performance, it should be obvious that it holds great promise for development as an ayahuasca analogue admixture plant or a source of DMT/5-MeO-DMT.