The Influence of Environmental and Agronomic Factors on Floret Site Utilization in Perennial Ryegrass

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ABSTRACT

This paper reviews some of the work carried out at the University of Nottingham on environmental and agronomic factors which affect floret site utilization in the ryegrass seed crop. Low average temperature at anthesis was shown to decrease floret site utilization. Level, timing of nitrogen application and lodging influenced floret site utilization. The use of growth regulators increased floret site utilization and yield. The future role of chemical manipulation and its influence on floret site utilization is discussed.

Additional index words: florets, seed set, 14C-assimilate, growth regulators, macro-environment, nitrogen, water.

INTRODUCTION

Much work has been carried out on the development of potential yield in ryegrass seed crops (Anslow, 1963; Ryle, 1964; 1966; Hebblethwaite, Wright and Noble, 1980; Hampton, 1983) but little on the utilization of that potential (Hill, 1980). Most ryegrass seed crops produce large numbers of floret sites per unit area and therefore potential yields. Estimates indicate that if all floret sites are utilized yields of around 8 t ha⁻¹ would be achieved in most crops (Hebblethwaite et al., 1980; Hampton, 1983). Actual percentage floret site utilization under farm conditions is usually only about 10% which results in yields of well under 1 t ha⁻¹.

Consequently this paper deals with environmental and agronomic factors affecting floret site utilization and not floret production.

ENVIRONMENTAL FACTORS

At the University of Nottingham an examination of macro-environmental factors during anthesis and its relationship to yield of the perennial ryegrass seed crop (cv. S.24) was carried out using data collected over a ten year period (Hampton and Hebblethwaite, 1983). Minimum screen temperature during the month of June, during the week of anthesis and during the week after anthesis was significantly related to seed numbers and yield. This factor accounted for over 70% of the variance in seed numbers recorded. Although measurement of the macro-environment is crude compared to micro-environmental measurements within the crop this finding which takes 10 differing seasons into account agrees well with micro-environmental responses reported by others (Jones and Brown, 1951; Hill, 1971; 1980). Consequently it must be assumed that low average temperatures at anthesis (i.e. below 8 C) are likely to decrease floret site utilization. Little is known why this should be the case and what sort of damage occurs. Further work into the effects of low temperature on floret site utilization needs to be carried out.

The only other weather factor related to seed numbers was wind velocity in the week following anthesis where a reduction was recorded with increasing velocity. Rainfall, radiation, and relative humidity had no significant influence on seed numbers (Hampton and Hebblethwaite, 1983). Irrigation experiments have also indicated that water stress equivalent to a profile soil water deficit of 90-100 mm will have little effect on floret site utilization (Hebblethwaite, 1977). Excess water during the period of seed set and development can increase secondary tillering and this could be at the expense of seed fill and consequently decrease yield.

AGRONOMIC FACTORS

Nitrogen experiments have shown that increasing the amount of spring applied nitrogen can increase the number of florets per unit area but percentage seed set can be
decreased (Hebblethwaite, et al., 1980). This may be a result of earlier and more severe lodging, or to increased competition for assimilates between floret site and secondary vegetative tillering (Hebblethwaite et al., 1980; Hampton, 1983; Clemence and Hebblethwaite, 1984). Vegetative tillers subventing developing fertile tillers compete for assimilates with the growing seed (Hampton, 1983; Clemence and Hebblethwaite, 1984). In a lodged crop (cv. S.24) assimilate movement from the flag and penultimate leaves was mostly down the plant to the subventing vegetative tillers. This was confirmed by Clemence and Hebblethwaite (1984) who also showed that during stem elongation, the ear was a net exporter of assimilate and that up to 10% of this assimilate was recovered from subventing vegetative tillers. Transfer of assimilates from vegetative to parent tillers was found to be low as only about seven percent of the 14C they fixed was exported (Hampton, 1983).

Delaying the application of nitrogen to ear emergence decreases the number of florets per unit area but increases seed set. This can be attributed to a reduction in the severity of lodging at anthesis, or a reduction in the number of potential seed sites per ear resulting in less competition between sites. However, this delay in nitrogen application decreases yield in spite of the increased seed set because of the reduced yield potential (Hebblethwaite et al., 1980). Late nitrogen application can also result in excess secondary tillering (Nordestgaard, 1980) particularly in wet seasons and this could result in further competition for assimilates.

High levels of nitrogen increase the severity and bring forward the time of lodging (Hebblethwaite and Ivins, 1977). Lodging decreases the proportion of florets that set seed (Burbidge et al., 1978). In S.24 the percentage of florets which set seed decreased from the base to the apex of the ear in a lodged crop but was more uniformly distributed in an erect crop (Burbidge et al., 1978). In S.24 the percentage seed set for each floret position was also found to be higher in erect crops (Burbidge et al., 1978). Lower seed set in lodged crops have been attributed to suppression or inhibition of anthesis (Burbidge, 1977) because of less favorable micro-environmental conditions (Hampton and Hebblethwaite, 1983) and decreased pollen dispersal (Wright and Hebblethwaite, 1979).

The above work on nitrogen and lodging indicated that the prevention of lodging by chemical means could significantly increase seed set and yield in ryegrass seed crops. In 1981 and 1982 work using the chemical paclobutrazol sprayed at spikelet initiation showed that this treatment significantly increased the number of seeds per spikelet present at final harvest by reducing the number of seeds aborted during seed development (Hampton and Hebblethwaite, 1985a) and this resulted in substantial increases in seed yield (Hampton and Hebblethwaite, 1985b). This increase due to paclobutrazol application was due to an alteration in the distribution of florets and seeds per spikelet, as both the basal and penultimate spikelets contained more florets and seeds than did those of untreated plants (Hampton and Hebblethwaite, 1985a).

Further work indicated that in untreated plants, assimilate recovery was lower from the terminal section of the ear, whereas in chemically treated plants, no differences were found between basal, intermediate or terminal sections of the ear. Assimilate demand at all sections of the ear were also increased when the ear and leaves were fed with 14CO2 in paclobutrazol treated plants (Hampton and Hebblethwaite, 1985a). This work shows that abortion of developing seeds is an important factor in contribution to low number of seeds harvested.

As well as the above effects this chemical was highly successful in preventing lodging by increasing stem base strength, reducing stem internode length, increasing root dry matter and leaf area duration. All these responses enabled large increases in seed yield (Hampton and Hebblethwaite, 1985b).

In the short term there is little the breeder can do to select for higher seed yield in known varieties. The use of growth regulators therefore has a great potential for the future. Paclobutrazol (Parlay) has been released since 1985 on a limited basis for commercial use in U.K. and U.S.A. herbage seed crops. Results to date have been promising. Further work is also being carried out on other growth regulators and results have been good (Hebblethwaite, Barrett and McGilloway, 1985). However, these products can result in upright crops which are highly susceptible to shedding prior to harvest under adverse conditions (Hampton, 1983). In the long term it is therefore important that chemical manipulation of seed shed is given research priority. Work started at the University of Nottingham in 1985 in this area but with no success to date (Hebblethwaite et al., 1985).

In the long term the herbage seed grower may be looking to multiple chemical use. Work at the University of Nottingham (Hampton and Hebblethwaite, 1984) has already shown that a combination of GA3 and paclobutrazol can reduce vegetative tillering prior to ear emergence, reduce stem length and lodging with a possible increase in seed set and yield. The next stage is to look for a chemical which will substantially increase seed set, seed retention, and transfer of assimilates to the seed. Added to this could be a chemical which would prevent shedding in an upright crop. Perhaps all these functions may be found in one or two chemicals in the future. This approach is not too far distant from commercial reality. The speed at which such developments will take place will depend on the funding of research in the future.

REFERENCES

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Factors Affecting Seed Yield in Breeding Material of Kentucky bluegrass (*Poa pratensis* L.)

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ABSTRACT

Factors affecting seed yield, including seed yield components, were determined in two breeding populations of Kentucky bluegrass (*Poa pratensis* L.). In both populations a higher number of inflorescences and spikelets had a positive effect on seed yield, but their effect was reduced by a smaller seed weight. It was concluded that the seed yield per plant could be used as a breeding objective when selecting for seed yield.

Additional index words: seed yield components, path coefficients, multiple regression.

INTRODUCTION

Kentucky bluegrass (*Poa pratensis* L.) is widely used as a turf grass in temperate areas and possesses favorable turf characteristics. However good the turf quality is, the ultimate commercial success of a cultivar will be determined by the economics of its seed production. Numerous cultivars have been developed that excelled in turf quality but were never marketed because of their inability to produce seed in large enough quantities. Examples are also known of cultivars that are high in seed production but poor in turf quality.

The breeder, therefore, is challenged to combine both turf quality and seed productivity in one and the same cultivar - two characteristics that act adversely on each other. Various studies have been undertaken to define the components determining seed yield and therefore should be the objectives in a selection program for higher seed yield (Dewey and Lu, 1959; Lewis, 1966; Knowles et al., 1970; Bugge, 1981; Wilson et al., 1981; Nguyen and Sieper, 1983). Often such studies have been based on a limited number of plants...