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Cocksfoot (*Dactylis glomerata* L.) Seed Production

**A Thesis Presented in Partial Fulfilment
of the Requirements for the
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ABSTRACT

Seed yield reduction due to variation in genotype, management, and incidence of diseases is common and well documented in grass seed crops. Two New Zealand cultivars (Grasslands Wana, Grasslands Kara) and two Japanese (Akimidori Makibamidori) cocksfoot cultivars from a three year old stand (sown in September 1991) at Grassland Aorangi Research Farm in the Manawatu were evaluated for their seed yielding capacity. In addition these cultivars were evaluated to determine the effectiveness of bactericide (Streptomycin), nematicide (Vydate/Oxamyl) or a combinations of bactericide and nematicide to determine their effect on seed yield with traditional Fungicide (Folicur) application being used as a control. The unit plot size was 1.2 X 3.0 m², with each plot containing 4 rows. A randomized block design with two factors (cultivar and pesticide) was utilized with 4 replications. In each cultivar pesticide were sprayed in four replicates from each block. The New Zealand cultivar Wana outyielded the other three cultivar and produced about 23%, 32%, and 70% higher pure seed/unit area than that cvs Kara, Makibamidori and Akimidori respectively. The ability of cv Wana to outyield other cultivar was largely due to its ability to produce a greater numbers of fertile tillers and higher number of florets/head. Seed yields in the New Zealand cultivar Kara and the Japanese cultivar Makibamidori were similar but significantly higher than cv Akimidori. The significantly higher seed yield of cv Kara was due largely to its significantly higher seed weight than the other cultivars. Similarly the higher seed yield in cv Makibamidori compared to Akimidori was mainly due to higher seed weight. The lower pure seed yield in cv Akimidori was apparently due to lack of proper photoperiodic effect or cold temperature during anthesis and its earlier seed developing resulted in more empty florets than the New Zealand cultivar and cv Makibamidori. Fertile tiller numbers spikelets/ head and florets/ head were significantly higher in cv Wana compared to the other 3 cultivars. However, the TSW was low. The TSW was highest in cv Kara. Highest recovery of pure seed was obtained from cv Wana in screen and blown fraction. Highest pure seed was obtained from cv Makibamidori in clean seed fractions. Foliar disease intensity in all the four cultivars was found to be similar at all 3 stages of plant growth although disease levels were generally low.

Percentage purity in clean seed as well as in different cleaning fractions varied depending on cultivar but cv Akimidori was always ranked lowest. Seed germination percentage in single and in multiple florets was higher in cv Akimidori compared to the other 3 cultivars.

Different cultivars reacted differently to the application of pesticide. Cultivar Wana produced the highest yield 103 g pure seed/m² in the Fungicide (Folicur) treatment compared to 55, 38 and 22 g/m² in cv. Kara, Makibamidori and Akimidori respectively. However all cultivars produced lower yields following the application of Streptomycin. Seed yield in cv Akimidori was not affected by any pesticide application. The lower yield in Streptomycin treatments was mainly due its phytotoxic effect on leaf tissue.

Seed yield in Fungicide, Vydate and in V+S treated plots was similar but significantly better than in Streptomycin treated plots. Fertile tiller numbers were also similar in these treatments but spikelet and total floret numbers were higher in the V+S treatment than in the Fungicide treatment. TSW and florets/ spikelets was not affected by pesticide application.

The recovery of pure seed was always lowest in the Streptomycin treatment in all fractions of machine cleaning of seed but was higher in V+S than Fungicide treatment, particularly in the machine clean fraction. However, the recovery of pure seed from the screen fraction did not vary significantly. Over all the foliar disease severity was low in Fungicide and V+S treatment and highest in Vydate treatment at maturity but no difference during vegetative growth or at peak flowering.

The percent purity varied only in the air screen fraction but was high in the Vydate treatment. Seed germination was high in all pesticide treatments and being above 90% in term of single florets and 85% in multiple florets with minor improvement in V+S treatment both in single and multiple florets and in Fungicide treatment with multiple florets only.

The second trial involved only one cultivar (cv Tekapo) and involved 4 plots from each block with 3 different types of fungicide Alto (cyproconazole), Bavistin (carbendazim), and Bravo (chlorothalonil) applied from flower initiation to harvest maturity at intervals of 14 to 21 day. No effect of fungicide occurred in seed yield or in yield components. Disease severity varied significantly only at harvest maturity and was lowest in Alto treated plots (2.75) compared to the control (4.25). However, no difference occurred in assessment at the vegetative stages or at peak flowering. No significant effect of fungicide was observed in terms of seed cleaning. The percentage purity was found higher in Alto and Bravo treated plots. Germination results were well above accepted levels (90%) in all fungicide treatments with Bavistin treatments being particularly useful.

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CHAPTER I

INTRODUCTION

Cocksfoot is an important perennial grass widely cultivated in temperate regions of the world. It is a stout, tussock forming plant which was brought to New Zealand in the 1840's and has a unique history of seed production initiated by the early settlers after clearing of heavy forest in the Banks Peninsula area (Christchurch) (Coulson 1979). The first seed production programme was initiated in 1852 by a farmer known as 'Cabbage' Wilson of Christchurch and spread to the Banks Peninsula area (Coulson 1979). Herbage seed production in New Zealand dates back more than 100 years with exports in the 1880s of 1400 tonnes of grass seed mainly cocksfoot (*Dactylis glomerata* L.), ryegrass (*Lolium* spp.) and tall fescue (*Festuca arundinaceae*) Mackay (1987). Cocksfoot is increasingly popular in New Zealand due to its ability to withstand dry conditions, being one of the most drought resistant temperate forage grasses (Norris & Thomas 1982; Volarie, 1991); its ability to grow in low fertility soils; its highly palatable forage production at the early growth stage; its companion ability with clover and other grasses and its ability to grow well in shade (Anon, 1965). Seed export is a major component of the New Zealand herbage seed industry totalling 15025 t in 1993 (Anon 1994). Cocksfoot is the most important New Zealand certified herbage grass seed crop after ryegrass with a total of 515 t being produced from 1000 ha in the 1994 harvest season. The two New Zealand cultivars, Grassland Wana (390 t) and Grassland Kara (97 t) made up the bulk of the seed produced, the former cultivar being bred for sheep pastures, while the latter is used mainly for dairy pastures (Rowarth *et al.*, 1991).

Although Grasslands Kara and Wana cultivars were bred under New Zealand conditions, they also have potential for use overseas, and exports of cocksfoot seed to countries such as Australia and Chile earned the New Zealand seed trade nearly \$ 600,000 in 1990. (Rowarth *et al.*, 1991). While seed exports of New Zealand cultivars continue to increase, there is the possibility of multiplication and re-export of seeds of overseas cultivars in New Zealand, particularly for the Japanese market, which uses cocksfoot as a component of dairy pastures, but does not produce seed. Seed requirements are imported primarily from USA (both US cultivars and Japanese cultivars multiplied in USA, B McCloy, pers. comm.).

In the 1992 harvest season, seed yields of both New Zealand cultivars averaged around 500 Kg/ha (MAF, 1994). Although yields of over 1000 kg/ha have been recorded (Rolston, 1991), factors influencing reduction in yields are varied but pathogens causing various diseases alone or in combination can be important. In recent years the introduction of rust resistant/tolerant cultivars like Wana and Kara has improved the performance and quality of cocksfoot but both leaf spot and seed head diseases can still be remain a serious problem, particularly in cool and wet seasons (Welty, 1989a). In New Zealand about 36 different diseases have been isolated from cocksfoot with most being due to fungal pathogens (Penycook, 1989). Among these, leaf spot disease caused by *Mastigosporium rubricosum* (Dearn. and Barth.) is considered important (Sprague, 1950; Welty, 1989a; 1991;) as well as the bacterial pathogen *Clavibacter rathayi* (Rathay's disease) recorded in Denmark (Skou, 1965) and in other countries (USA, Switzerland etc.). The causal agent of Rathay's disease or yellow slime disease (Denmark) was also first recorded in New Zealand in 1956 (Johnston, 1956). The main damage caused by this pathogen is profuse development of a yellow bacterial slime cover on the upper parts of plants, especially the inflorescence. Such parts often become dwarfed and distorted, and the inflorescence may fail to emerge from the sheath which is firmly stuck together by slime (CMI, 1973). Symptoms similar to Rathay's disease were noticed in various seed crops in growers fields at Canterbury during the 1993-94 cropping season. Preliminary investigation at Lincoln University indicated the presence of some fungal pathogens (*M. rubricosum*, *Ascochyta* sp., *A. sorgi*, *Puccinia* sp., *Stemphylium* sp.) and a bacterial pathogen *Pseudomonas syringe* (Lincoln Univ. investigation unpublished report). Similarly preliminary investigations on inflorescences from seed crops in the Manawatu and seed samples from Christchurch also suggested the presence of the fungus *M. rubricosum*, and the bacterium *Pseudomonas* spp. as well as another bacteria. The colony of this isolated bacterium appears similar to an authenticated culture of *C. rathayi* (Seed Technology Centre, Massey University). In addition some free living/ fungal and bacteria feeding, and plant parasitic nematodes were also observed in a cocksfoot seed crop at AgResearch Grasslands Experimental Station, Aorangi near Palmerston North. It has been established in wheat and in ryegrass that the nematode *Anguina tritici* can transmit *Clavibacter tritici* in wheat (Sabet, 1954) causing identical disease symptoms to those observed in cocksfoot (Sabet 1954; CMI, 1973) although it has not been established as a pathogen transmission agent in cocksfoot. Nevertheless this does suggest the possibility of nematode vector transmission of *C. rathayi* in cocksfoot (CMI, 1973). In Australia ryegrass toxicity where seeds are replaced

by nematode larvae in association with the bacterium *C. rathayi* (Bird and Stynes, 1977) which also produces toxins) can result in cattle dying after eating infected seed (Berry and Wise, 1975; Price *et al*, 1979a, Stynes and Bird, 1980; Stynes and Wise, 1980). In this case the nematode is also a species of *Anguina funesta* (Price *et al* 1979b) and the toxin bacterium is also *C. rathayi* (Stynes *et al*, (1979).

Fungicides are an effective way of controlling leaf diseases, especially when one or more fungal pathogens occur on the same plant. Their use has been studied since the early 1940s to control rust in cool-season grasses grown for seed (Hardison 1963 and 1975). More recently, however, increased seed yield, following the application of fungicide (Hampton, 1986, Rolston, *et al* 1989, Welty, 1991), has been shown to improve seed yield, herbage growth and the establishment of cocksfoot and other grasses (Clements *et al*, 1982; Spaul and Mewton, 1984 Clements *et al* 1985). Similarly Rolston *et al* (1989) has reported a 21 % increase in cocksfoot seed yield following fungicidal application (propiconazole) to cv Grasslands Wana. Although fungicides applied before or at anthesis have been shown to increase seed yield in many temperate grasses (including cocksfoot) mean commercial seed yields in New Zealand over the last few years have remained constant in major cocksfoot seed growing areas despite the application of fungicides which have been found to be effective elsewhere.

The present investigation was designed to meet three objectives:

- (1) To determine the possible role of fungicide application, bactericide use and/or the application of a nematicide in increasing cocksfoot seed yield and quality. These areas of chemical use have not been extensively studied in New Zealand and were chosen in an attempt to try to improve the unexplained low yields of cocksfoot seed experienced by many New Zealand seed producers, particularly during the 1993 and 1994 harvest seasons.
- (2) To compare the seed yield and quality of four cocksfoot cultivars two of New Zealand origin (Wana and Kara) and two from Japan (Makibamidori and Akimidori) and their reaction to chemical application.
- (3) To evaluate the effectiveness or otherwise of three different fungicides (Alto, Bavistin and Bravo) on the seed yield and yield components of cocksfoot cv Tekapo.