GRASSHOPPER DAMAGE TO PINE CONTAINER SEEDLINGS

IN SOUTHEASTERN MANITOBA

BY

L.D. NAIRN and K. FRONING

INFORMATION REPORT NOR-X-191
SEPTEMBER 1977

NORTHERN FOREST RESEARCH CENTRE
CANADIAN FORESTRY SERVICE
FISHERIES AND ENVIRONMENT CANADA
5320 - 122 STREET
EDMONTON, ALBERTA, CANADA
T6H 3S5

Nairn, L.D. and K. Froning. 1977. Grasshopper damage to pine container seedlings in southeastern Manitoba. Fish. Environ. Can., Can. For. Serv., North. For. Res. Cent. Inf. Rep. NOR-X-191.

ABSTRACT

Field-planted container seedlings of jack pine (*Pinus banksiana* Lamb.) and red pine (*Pinus resinosa* Ait.) were heavily damaged by grasshoppers when high populations of the insect occurred on planting sites in southeastern Manitoba. Seedling mortality from grasshopper feeding occurred only during the first year of planting. Seedlings treated with the animal repellents Skoot and R-55 in greenhouse experiments were protected only initially from grasshopper damage, and phytotoxicity was severe. In field trials the insecticide dimethoate protected seedlings 6-8 days through insect population reduction, but thereafter the grasshoppers reinvaded the planting area. It is recommended that reforestation by container seedlings be completed within one growing season following cutting, before damaging grasshopper population buildup. Alternatively, conventional stock or late fall planting of container stock may be used on high-hazard planting sites.

RESUME

Des semis en potets de Pin gris (*Pinus banksiana* Lamb.) et de Pin rouge (*Pinus resinosa* Ait.) plantés dans des stations du sud-est du Manitoba furent sérieusement endommagés par les sauterelles lorsque les populations de cet insecte se manifestèrent avec intensité. La mortalité des plants causée par les sauterelles voraces se produisit seulement au

cours de la première année. Les semis traités au répulsif pour animaux nommé Skoot et au R-55 lors d'expériences en serres ne furent protégés qu'au début et on nota une phytotoxicité sévère. Lors d'essais sur le terrain, l'insecticide diméthoate protégea les semis pendant 6 à 8 jours en réduisant les populations d'insectes, mais par la suite, les sauterelles réenvahirent la plantation. Les auteurs recommandent de terminer rapidement le reboisement (en une seule saison de croissance) dès après la coupe, avant que les populations de sauterelles dévastatrices ne se développent. Alternativement, on peut utiliser le plantage classique ou planter en potets tard l'automne, dans les stations hautement exposées aux insectes.

CONTENTS

INTRODUCTION

Grasshoppers have been responsible for severe crop losses to cereal grains at recurring intervals since the advent of agriculture in the Prairie Provinces. The first reported grasshopper damage to farm crops in Manitoba was in 1812 (Wood 1955). Severe outbreaks in Manitoba occur approximately every 10 years and last an average of 5 years (Mitchener 1955). In recent years, extensive surveys combined with cultural and chemical control practices have been required to minimize crop losses.

Until recently, grasshoppers were considered an unimportant forest pest, although they have eaten the leaves and green bark of both deciduous and coniferous trees planted for shelterbelts and shade trees in the north-central United States (Craighead 1950). In Michigan, pine seedlings (*Pinus* sp.) planted in heavy grass areas for Christmas tree production suffered extensive damage by grasshoppers (Wallner and Butcher 1973). In his research on jack pine (*Pinus banksiana* Lamb.) seeding plots in southeastern Manitoba, Sims (1970) reported extensive losses of young seedlings due to stem clipping at ground level by unidentified organisms. Grasshoppers were the suspected agent because they were present in large numbers.

The advent of container-reared tree seedlings in the late 1960's has led to the outplanting of very young and tender seedlings, often only 12-16 weeks old. These small, succulent, and palatable seedlings are particularly vulnerable to insect or mammal damage.

The Canadian Forestry Service, in cooperation with the

Manitoba Department of Renewable Resources, carried out investigations to (1) confirm grasshoppers as the causal agent of losses to field-planted container seedlings and (2) make management recommendations to alleviate the problems. This report summarizes the field observations and greenhouse tests carried out from 1971 to 1975.

SITES AND OBSERVATIONS

The observations on grasshopper damage were made in the Sandilands Forest Reserve and Belair Forest Reserve of Manitoba. The Sandilands Forest Reserve is located in southeastern Manitoba and constitutes part of Rowe's (1972) Rainy River (L.12) Section of the Great Lakes-St. Lawrence Region. It is an island of higher land, with water-washed till and outwashed sands, that was not covered by glacial Lake Agassiz. Jack pine is the predominant tree species on the sandy uplands, with scattered pure and mixed stands of red pine (*Pinus resinosa* Ait.) occurring in the southern and eastern portions of the area. The mean annual precipitation is 56 cm; mean annual temperature is 5°. Summers are usually hot with frequent periods of drought. The Belair Forest Reserve, (80 km) to the north, is located in Rowe's (1972) B15 Manitoba Lowlands Section. The area of grasshopper infestation occurs on a sandy moraine of outwash deposits and is similar to the Sandilands in soils and climate.

Suspected grasshopper damage to container stock in Manitoba was first observed in 1971 in the Belair and Sandilands Forest reserves in small (0.5-1 ha) plantations on unprepared sites. Twelve-week-old jack pine seedlings greenhouse reared in Ontario-type (1.9 cm) split

plastic tubes and planted in mid-June suffered 60-70% mortality by early August. Both plantation areas were replanted on June 29, 1972, with 16-week-old jack pine seedlings reared in BC/CFS styroblocks and #408 paper pots. These seedlings were greenhouse-reared for 12 weeks and hardened off in cold frames for a further 4 weeks. The seedlings planted in the Belair plantation suffered 25% mortality within 6 days following planting and 40% by the end of the season. These losses were caused by stem girdling, top clipping, needle chewing, and complete consumption of entire plants down to the root collar. The residual seedlings from the 1971 planting suffered no further mortality in 1972. In the Sandilands plantation no seedling mortality attributable to feeding damage was observed in 1972. This appeared to be related to the collapse of the grasshopper population in the area.

In mid-June of 1973, the Canadian Forestry Service established test plantings of jack pine grown in various container types in four locations in the Sandilands. The planting stock was 16 weeks old. These planting sites had been clear-cut in the winter of 1971-72 and barrel-furrowed in the summer of 1972. Operational plantings with jack pine container stock were carried out in the Sandilands by the Manitoba Department of Renewable Resources from August 12 to September 10, 1973 on similar sites. Low grasshopper populations were observed on all the 1973 container planting sites and damage was neglible. No seedling mortality from feeding injury was observed in the 1971 or 1972 plantations in the Belair Forest Reserve.

In 1974, injury and losses apparently attributable to grasshoppers were detected on three areas in the Sandilands, newly planted with pine container seedlings. Two of the areas were provincial

operational plantings of 16-week-old seedlings reared in #313 paper pots, one with jack pine and the other with red pine. The area planted to jack pine had been cut in the fall of 1971 and barrel-furrowed in the summer of 1972. The red pine planting area was a replanting of a 1971 plantation that had been barrel-furrowed in 1970. By 1974 the furrows were heavily invaded by grasses. The third area was a 1974 planting trial by the Canadian Forestry Service of container types established in late June with 18-week-old jack pine on a 1971 cutover that had been barrel scarified in the summer of 1972. Seedling mortality in all three areas continued to increase until the end of September 1974 and then ranged from 20% to 50%. Special test plots established by replanting in late July in one of the more severely damaged plantations showed renewed losses from grasshopper feeding of 80% within 2 weeks. Test plots established as late as August 22 in other areas lost 28% of their seedlings by late September. Adjacent to one of the areas most severely affected in 1974 was a plantation that had been fall-planted with container jack pine seedlings in 1973. In 1974 no seedling damage was observed in that plantation, indicating that the seedlings were apparently no longer attractive to grasshoppers in the next year after planting.

GREENHOUSE OBSERVATIONS

While grasshoppers were always presumed to be the cause of observed pine seedling damages, there were no substantiating field observations or positive evidence. A live collection of grasshoppers was obtained from one of the planting sites on September 13, 1974 and used in feeding studies on container pine seedlings. Six species of

grasshoppers were collected: *Camnula pellucida* (Scudd.), *Dissosteira carolina* (L.), *Melanoplus dawsoni* (Scudd.), *M. bivittatus* (Say), *M. bilituratus* (Walk.) and *M. borealis* (Fieb.). Fifth-instar nymphs and adults were placed in two cages in the laboratory containing 18-week-old containerized jack pine seedlings. Each cage contained 15 seedlings and 60 grasshoppers of various species, but predominantly *M. bivittatus* and *M. bilituratus*.

The caged grasshoppers were observed during the daytime for 15 minutes every hour. Active feeding was observed on the second day of the test. Within 5 days, all damage symptoms observed in the field were also found in the cages, including stem girdling, top clipping, needle chewing, and stem consumption down to the root collar (Fig. 1 and 2). The species most actively feeding were *M. bilituratus*, *M. bivittatus*, and *M. borealis*.

Results were comparable in a similar test conducted under greenhouse conditions with red pine seedlings in 1975. Damage by first- and second-instar nymphs was negligible, while that by fourth- and fifth-instar nymphs and adults was the most destructive. This finding, supported by field observations, suggests that the most active feeding and damage in the Sandilands will start in late June or early July. In 1975, grasshoppers started to feed destructively about July 8 and continued until about September 25, with a peak occurring between July 15 and August 15.

In greenhouse tests, the deletion of fertilizer during rearing of seedlings to reduce succulence appeared to have no effect on grasshopper feeding. This was supported in field tests with unfertilized seedlings.

Fig. 1. Grasshoppers feeding on needles of container pine seedlings. Note girdled stem of seedling at left.

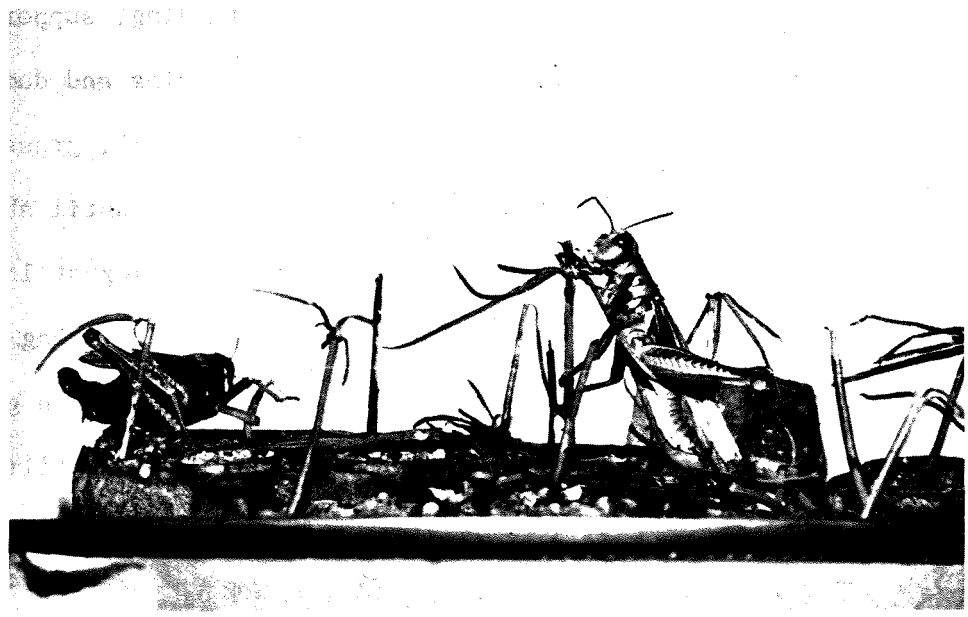

Fig. 2. Grasshoppers feeding on stems following top clipping of container pine seedlings.

Grasshopper damage in Manitoba has not been reported or observed on field-planted 2-0 and 3-0 conventional (bare-root) jack pine and red pine seedlings, or on field-planted container stock of these species in their second growing season following planting. However, tests with jack and red pine seedlings reared in containers for 16 weeks, overwintered at the nursery, and then field-planted in the spring showed 15% and 40% mortality respectively for the two species by the end of the first growing season.

GRASSHOPPER REPELLENCY AND SEEDLING PHYTOTOXICITY

Relatively little research has been carried out on the use of insect repellents on grasshoppers in agricultural areas, and results to date have not been encouraging. In view of the need to control damage of planted container stock, trials were initiated to determine if repellents could be used to protect seedlings.

In March 1975, the animal repellents Skoot* and R-55** were tested for seedling phytotoxicity and grasshopper repellency. Agarol 90, an emulsifier, and a latex sticker were also tested. The phytotoxicity tests were conducted under field conditions on 16-week-old actively growing jack pine container (#313 paper pots) seedlings using the following treatments:

1. Skoot (50% Skoot + 50% H_2O)
2. Agarol 90 (10% Agarol 90 + 90% H_2O)
3. Skoot + Agarol 90 (45% Skoot + 10% Agarol 90 + 45% H_2O)
4. R-55 (2% R-55 + 98% H_2O)
5. R-55 + Latex (2% R-55 + 98% Latex sticker)

---

* bis (dimethylthiocarbamoyl) disulfide. Plant Products Ltd. Bramalea, Ont.

** tertiary-butylsulfenyldimethyldithiocarbamate. Phillips Petroleum Co., Bartlesville, Oklahoma.

6. Controls

The solutions were sprayed or brushed on to wet the foliage of 10 approximately 13-cm tall pine seedlings per treatment. Within 21 days, all seedlings showed phytotoxic reaction, while the controls remained healthy. Symptoms ranged from needle curling and tip dessication with Skoot and R-55 to complete mortality with Agarol 90 and Skoot. Agarol alone resulted in tip necrosis of some seedlings. Seedlings treated with the mixture of R-55 plus latex sticker reacted similarly to those treated with Agarol 90 alone. Phytoxicity occured within 6 to 21 days after treatment.

The repellency tests were conducted in cages using the same single treatments as outlined above. For each treatment, a cage was set up containing 10 treated and 10 untreated seedlings. Twenty grasshoppers (fourth- and fifth-instar *M. bivittatus*) were released in each cage with no available food. After 3 days, some feeding had started on the control seedlings. Within 6 days, many of the treated plants exhibited phytotoxicity and noticeable grasshopper damage to the needles. Concurrently, many of the control seedlings had been consumed. After 2 weeks, all chemical treatments showed phytotoxicity and some degree of grasshopper damage. In general, the control seedlings were consumed first and then the treated seedlings.

FIELD TESTS OF DIMETHOATE TO PROTECT CONTAINER PLANTATIONS

Controlling grasshoppers with insecticides in agricultural field crops is common. Dimethoate was applied in 1975 in a container plantation to examine its effectiveness for control and protection. This

insecticide was selected because it has been widely used for controlling grasshoppers in cereal grains. Two test plantings (Areas 1 and 2, Table 1) were established in the Sandilands, approximately 35 km apart, where grasshopper populations were known to be high. Each area supported scattered, open-growing mature jack pine that had been clear-cut in the winter of 1972-73 and barrel-furrowed in the summer of 1973.

On August 5, 1975, one day prior to container planting in Area 1, a 1% solution of dimethoate 40E was applied to the test plot and to a surrounding 31-m buffer strip to control reinvasion from untreated areas. Application was made by means of a hand-operated backpack sprayer at a rate of 0.28 kg/ha active ingredient. Following the spray application, a 7 x 7 m area in the center of the block was planted with 100 jack pine and 100 red pine 16-week-old seedlings reared in #313 paper pots. Control plots were established outside the spray block.

TABLE 1. Seedling loss following dimethoate treatment

	Mortality after					
	6 days		8 days	20 days	21 days	
	jP	rP	jP	jP	jP	rP
Area 1 Treated	6	4			75	35
Control	70	13			82	36
Area 2 Treated			1	6		
Control			68	90		

After 6 days, grasshoppers had killed 70% of the jack pine in the control plots and 6% of jack pine in the treated area (Table 1). Red pine in the control plots suffered 13% mortality compared with 4% in the treated area. However, after that time reinvasion of grasshoppers into the treated area rapidly increased. Losses were approximately equal in both the sprayed and control areas after 21 days: jack pine mortality

was 82% and 75% for the control and treated areas respectively, and red pine mortality was 36% and 35% for the control and treated areas.

The test was repeated in Area 2 on August 14, 1975 using only jack pine seedlings. Good protection was provided in the treated area for 8 days, with seedling losses of only 1%, while the controls suffered 68% mortality (Table 1). Although grasshopper numbers were observed to increase in the treatment area, losses after 20 days were only 6%, while the controls showed 90%.

DISCUSSION AND CONCLUSIONS

High grasshopper populations in forest plantation areas of southeastern Manitoba coincide with high populations in the surrounding agricultural areas. Damage can be expected to occur periodically in the future where container seedlings have been planted in the spring or summer, particularly on cutovers 2 years old and older.

Early spring planting of overwintered stock, although reducing overall susceptibility, must still be regarded as a high risk. Late fall field planting would presumably reduce this susceptability to almost zero. Conventional bare-root sotck and fall-planted container stock have not been damaged in the past because they are apparently not attractive to grasshoppers. However, narrowing the container planting season to fall planting defeats the major reason for using the container system: the possibility of planting throughout the growing season. In addition, fall planting in Manitoba has been only marginally successful.

Tested conventional animal repellents have proven ineffective in repelling grasshoppers and highly toxic to container seedlings used in the trial. There appears to be little promise at present of achieving

beneficial results using repellents.

Systemic insecticides such as dimethoate may provide acceptable control if reinvasion by grasshoppers is prevented by providing a treated buffer zone. Tests showed that a 31-m buffer zone was inadequate. However, in view of the borader environmental impact and costly application of systemic insecticides, this method is of questionable value to operational programs at this time.

The best solution appears to lie in the proper timing of reforestation. Since grasshoppers require at least two seasons after cutting to increase to levels capable of causing serious losses, a fall or winter cut reforested within the first growing season after logging will not sustain major losses. In the first growing season, grasshopper populations will be low, and if seedlings are established, they will be resistant the following year. Delaying planting on cutovers for one or more seasons will increase grass invasion and rapid grasshopper population buildup. Scarification, though necessary for successful planting, assists grasshopper buildup by making available ideal oviposition sites. It is important, therefore, that scarification be carried out just prior to planting.

Since high grasshopper populations in forested areas coincide with similar conditions in surrounding agricultural areas, the agricultural predictions can be used to identify high-hazard years.

REFERENCES

Craighead, F.C. 1950. Insect enemies of eastern forests. U.S. Dep. Agric. Misc. Publ. 657. 679 pp.

Mitchener, A.V. 1955. A history of grasshopper control in Manitoba. Proc. Entomol. Soc. Manit. 11:40-48.

Rowe, J.S. 1972. Forest regions of Canada. Environ. Can., Can. For. Serv. Publ. 1300.

Sims, H.P. 1970. Germination and survival of jack pine on three prepared cutover sites. Can. Dep. Fish. For., Can. For. Serv. Publ. 1283. 19 pp.

Wallner, W.E. and J.W. Butcher. 1973. Christmas tree insect management. Mich. State Univ. Coop. Ext. Serv. Ext. Bull. E-353. 30 pp.

Wood, H.E. 1955. The evolution in grasshopper control organization in Manitoba. Proc. Entomol. Soc. Manit. 11:50-55.