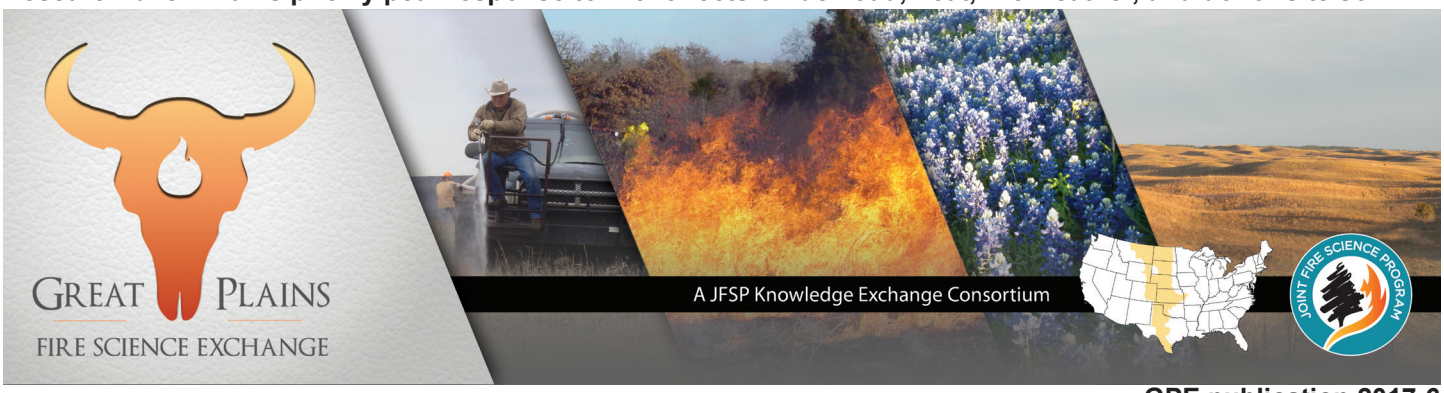

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Plains prickly pear response to fire: effects of fuel load, heat, fire weather, and donor site soil

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INTRODUCTION

Prickly pears are native plants that provide food and habitat for wildlife. However, they can reduce forage and increase livestock injury when there are too many of them. Plains prickly pear is adapted to fire, re-growing from seeds, roots, and pads, but fire can also kill plants. Fire temperature at or near the soil surface along with the speed of the fire may affect how much the fire damages the cacti. Rangeland fires are generally hotter when the humidity is low, air temperature is high, and grass is abundant.

EXPERIMENT 1

Ten healthy pads per plant were collected from 4 cacti growing on each of 3 soil types (claypan, gravel and silt) in southeastern Montana. The 120 pads were planted in individual pots in the greenhouse and allowed to grow for three months.

TREATMENT

Dry grass was collected to use as fuel for the fires. Fires were conducted outside. A fire cage made of wire mesh and a steel plate floor was constructed. Five fuel loads were created by spreading grass across the bottom of the cage at rates of 0, 1300, 2700, 4000, and 5400 pounds/acre.

One pot containing a cactus plant from each soil type was placed in the cage. Two thermocouple were placed near each plant, one at the mid-point of the plant and one laid on the soil surface. A fire line was created at the edge of the cage, about 25 inches away from the pots. Air speed was at least 5 miles per hour (mph). Two fire severity levels were tested. For moderate fire conditions, humidity was kept between 30% and 45%, and air temperature between 59 and 77 degrees Fahrenheit (F). For severe fire conditions, humidity was less than 35% and air temperature was greater than 86 degrees Fahrenheit. During the fire, thermocouple temperatures were recorded at one-second intervals.

Figure 1. Plains prickly pear.

Following the fire treatment, pots were returned to the greenhouse and allowed about 3 months to recover. Plants were evaluated for damage. If there was no green on the plant, it was considered dead. If the original pad that was planted had no green, that pad was considered dead. Pads that had grown above the pad that was originally planted were cut and weighed.

RESULTS

Root mass was reduced 58% across all fuel loads. Fuel load had the most effect on how hot the fire was and how long high temperatures affected the plant. Fuel loads of 1300 pounds/acre resulted in cactus pad mortality of 29%, and at 5400 pounds/acre, pad mortality was 72%. New pad growth was minimal across all treatments. Total plant weight declined about 55% with a fuel load of 1300 pounds/acre and declined over 90% at higher fuel loads. Whole plant mortality was most affected by how hot temperatures were at the soil surface and then by how long conditions remained hot.

EXPERIMENT 2

Ten cacti within each of 8 almost two acre plots were marked with tags and the number of pads on each cactus was recorded. Fuel load was estimated by clipping grass and collecting litter samples from each plot. The plots were burned in late August with an average fuel load of 1600 pounds/acre, at 79 degrees F, 34% relative humidity, and with 5-20 mph wind speeds. Pads were evaluated for damage 2, 8 and 11 months after the fire.

RESULTS

New pad growth on burned cacti was reduced by 91% two months after the fire. However, a year later, the burned plants only had 43% fewer pads than the unburned cacti as damaged plants rapidly regrew new pads. Plant mortality was 15%. Wildlife (pronghorn and rabbit) browsing and insect damage was found on 83% of the burned plants but only on 8% of the unburned plants.

MANAGEMENT IMPLICATIONS

Grass fuel load was the most important factor in increasing cactus damage and plant death. To accumulate adequate grass fuel, grazing may need to be reduced or deferred until after the fire, or fire may need to be conducted after a summer with good growing conditions. However, at any fuel load level, fire reduced cactus pad survival and plant weight. Plant death increased as plants were exposed to fire temperatures above 140 degrees Fahrenheit for longer periods of time. Most grass fires have temperatures that exceed 140 degrees F, so the duration of the period of heating is very important. Fuel loads of 2700 pounds/acre or above are much more likely to fuel fires with longer periods of duration.

With adequate grass fuel near the cacti, moderate weather conditions were as successful as severe weather conditions in causing plant damage and death. When grass fuel isn't abundant, severe weather conditions were more likely to be successful. A range of moderate to severe prescribed burning conditions expands the opportunities for planning burns.

The more cactus pads a plant has, the more likely that at least some of them will survive the fire and regrow. Multiple fires may be needed to adequately control cacti. After fire, livestock as well as wildlife may use the cacti as food. Browsing and insect damage may increase the impact that fire has on controlling cacti for up to 4 years.

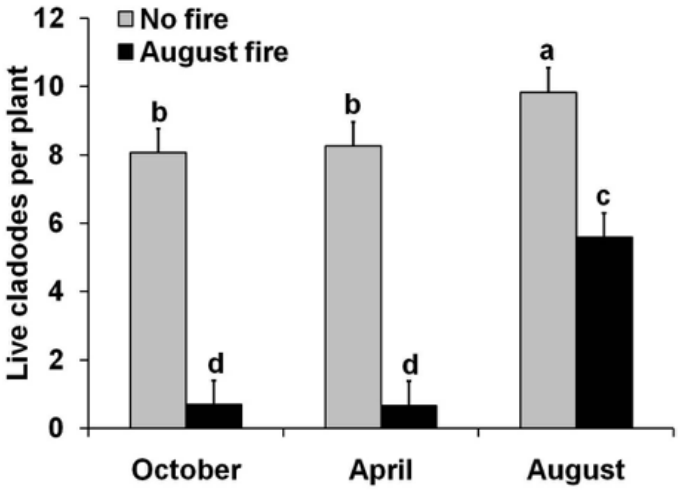

Figure 2. Number of live cladodes per prickly pear plant in nonburned and burned 0.75-ha plots 2, 8, and 12 mo following August fires. Means with the same letter do not differ (a50.05).

Original publication:
Vermeire, L.T. and A.D. Roth. 2011. Plains prickly pear response to fire: Effects of fuel load, heat, fire weather, and donor site soil. Rangeland Ecology and Management 64:404-413.