平地无风条件下蒙古栎阔叶床层的火行为III. 火线强度、可燃物消耗和燃烧效率分析及预测模型

张吉利,刘礴霏,邸雪颖,褚腾飞,金森**

(东北林业大学林学院, 哈尔滨 150040)

Fire behavior of *Quercus mongolica* leaf litter fuelbed under zero-slope and no-wind conditions. III. Analysis and modelling of fireline intensity, fuel consumption, and combustion efficiency.

ZHANG Ji-li, LIU Bo-fei, DI Xue-ying, CHU Teng-fei, JIN Sen

(College of Forestry, Northeast Forestry University, Harbin 150040, China)

摘要

以东北地区针阔混交林重要建群种和伴生种蒙古栎为对象,在平地无风条件下进行室内点烧试验,分析含水率、载量和厚度对蒙古栎凋落叶床层火线强度、消耗量和燃烧效率的影响,并对相关模型进行了验证.结果表明: 含水率、载量和床层厚度对蒙古栎凋落叶床层火线强度、消耗量和燃烧效率均有显著影响,并且3个指标之间存在交互作用.在已有模型中,Byram模型需参数调整后方可用于本地凋落叶可燃物,其重新估计的a、β拟合值分别为98.009和1.099，得到的预测值均方根误差为8.676 kW·m^{-1},平均相对误差为21.0%, R^2为0.745.对Albini提出的燃烧效率模型参数a、b的重新估计值分别为0.069和0.169,得到的预测值均在93.0%以上,绝大多数偏高.Consume模型适用性较强.新建立的火线强度、消耗量和燃烧效率的一般线性模型调整后的R^2分别为0.82、0.73和0.53,均方根误差分别为8.266 kW·m^{-1}、0.081 kg·m^{-2}和0.203.在低强度地表火中,细小可燃物可能不会被完全消耗，现有一些系统中将凋落叶和细小可燃物按全部消耗处理,将高估碳的释放量.

关键词： 火线强度 消耗量 含水率 载量 床层厚度 预测模型 蒙古栎

Abstract:

Mongolian oak (*Quercus mongolica*) is an important constructive and accompanying species in mixed broadleaf-conifer forest in Northeast China. In this paper, a laboratory burning experiment was conducted under zero-slope and no-wind conditions to study the effects of fuel moisture content, loading, and thickness on the fireline intensity, fuel consumption, and combustion efficiency of the Mongolian oak leaf litter fuelbed. The fuel moisture content, loading, and thickness all had significant effects on the three fire behavior indices, and there existed interactions between these three affecting factors. Among the known models, the Byram model could be suitable for the prediction of local leaf litter fire intensity only after re-parameterization. The re-estimated a and β parameters of the re-parameterized Byram model were 98.009 and 1.099, with an adjusted determination coefficient of 0.745, the rooted mean square error (RMSE) of 8.676 kW·m^{-1}, and the mean relative error (MRE) of 21%, respectively (R^2=0.745). The re estimated a and b by the burning efficiency method proposed by Albini were 0.069 and 0.169, and the re estimated values were all higher than 93%, being mostly overestimated. The Consume model had a stronger suitabi lity for the fuel. The R^2 of the general linear models established for fireline intensity, fuel consumption, and burning efficiency was 0.82, 0.73 and 0.53, and the RMSE was 8.266 kW·m^{-1}, 0.081 kg·m^{-2}, and 0.203, respectively. In low intensity surface fires, the fine fuels could not be completely consumed, and thus, to consider the leaf litter and fine fuel in some forest ecosystems being completely consumed would overestimate the carbon release from forest fires.

Key words: fireline intensity fuel consumption moisture content fuel loading fuelbed thickness *Quercus mongolica*.

没有本文参考文献

[1] 张吉利,刘礴霏,邸雪颖,褚腾飞,金森**. 平地无风条件下蒙古栎阔叶床层的火行为Ⅱ.火焰长度和驻留时间影响因子分析与预测模型[J]. 应用生态学报, 2912, 23(11): 3149-3156.

[2] 张吉利,毕武,王晓红,王孜博,李迪飞**. 雷击火发生的影响因子与预测研究进展[J]. 应用生态学报, 2013, 24(9): 2674-2684.

[3] 于飞1,3,史晓晓2,易现峰3,4**,王得祥1. 蒙古栎种子相对丰富度对小兴安岭5种木本植物种子扩散的影响[J]. 应用生态学报, 2013, 24(6): 1531-1535.

[4] 于宏洲,金森**,邸雪颖. 以小时为步长的大兴安岭兴安落叶松林地表可燃物含水率预测模型[J]. 应用生态学报, 2013, 24(6): 1565-1571.

[5] 池婷1,徐驰1,刘茂松1**,张明娟2,杨雪姣1. 干旱区沙枣-芨芨草群落土壤有机碳的空间格局[J]. 应用生态学报, 2013, 24(10): 2725-2730.

[6] 金森**,颜雪娇 . 帽儿山地区10种灌木生长期内含水率变化及预测模型[J]. 应用生态学报, 2012, 23(12): 3317-3324.

[7] 金森,刘礴霏,邸雪颖,褚腾飞,张吉利. 平地无风条件下蒙古栎阔叶床层的火行为Ⅰ.蔓延速率影响因子与预测模型[J]. 应用生态学报, 2012, 23(01): 51-59.

[8] 程徐冰,韩士杰,张忠辉,周玉梅,王树起,王学娟. 蒙古栎不同冠层部位叶片养分动态[J]. 应用生态学报, 2011, 22(09): 2272-2278.

[9] 李 娟,苟丽霞,胡小敏,任福平,卫军峰,安德荣. 气象因素对陕西省苹果褐斑病流行的影响及预测模型[J]. 应用生态学报, 2011, 22(01): 268-272.

[10] 颜坤;陈玮;张国友;何兴元;李响;徐胜. 高浓度二氧化碳和臭氧对蒙古栎叶片活性氧代谢的影响[J]. 应用生态学报, 2010, 21(3): 557-562.

[11] 潘敖大, 高苹, 刘梅, 王春乙. 基于海温的江苏省水稻高温热害预测[J]. 应用生态学报, 2010, 21(01): 136-144.

[12] . 北京松山自然保护区蒙古栎林的空间结构特征[J]. 应用生态学报, 2009, 20(08): 1811-1816.

[13] 张国友[1,2];何兴元[1];唐玲[1,2];颜坤[1,2];陈玮[1];徐胜[1];李响[1,2]. 高浓度臭氧对蒙古栎叶片酚类物质含量和总抗氧化能力的影响[J]. 应用生态学报, 2009, 20(03): 725-728 .

[14] 武静莲[1,2];王淼[1];蔺菲[1];郝占庆[1];姬兰柱[1];刘亚琴[3]. 降水变化和种间竞争对红松和蒙古栎幼苗生长的影响[J]. 应用生态学报, 2009, 20(02): 235-240 .

[15] 高苹[1];武金岗[2];杨荣明[3];刘梅[1];黄敬峰[4]. 江苏省稻纵卷叶螟迁入期虫情指标与西太平洋海温的遥相关及其长期预报模型[J]. 应用生态学报, 2008, 19(09): 2056-2066 .