

Minnesota Forestry Research Notes

No. 235
April 15, 1972

Effect of Hazel on the Nutrient Composition of Annual Litter and Forest Floor in Jack and Red Pine Stands

J. C. Tappeiner and A. A. Alm^{1/}

Beaked hazel (*Corylus cornuta*) is a very common shrub in red pine (*Pinus resinosa*) and jack pine (*P. banksiana*) stands in northern Minnesota. Forest managers often want to eliminate it or greatly reduce its density because it may form a dense layer and retard pine regeneration. However, little is known about the role of hazel undergrowth in nutrient cycling and its possible benefit to the soil.

Alway and Zon (1930) report the amount and chemical composition of litter and forest floor in several jack and red pine stands in northern Minnesota, but they had cleared the undergrowth from their plots and did not measure its effect. Maki (1950) found that hazel leaves were relatively rich in Ca, and he reported that in a virgin red pine stand the hazel constituted about 25% of the annual litter fall and that the concentrations of N and Ca were higher in the forest floor where hazel was present.

The purpose of the study reported here was to estimate the effect of a hazel undergrowth on the weight and nutrient composition of the annual litter fall and of the forest floor in jack and red pine stands.

Methods:

The study site was the Cloquet Forestry Center in northeastern Minnesota where the soil is a relatively infertile sand of the Omega series. The study was done in a 50-year-old jack and a 60-year-old red pine stand where hazel occurred in patches about 2-10m in diameter and formed a discontinuous undergrowth layer.

Samples of 1970-1971 litter and the forest floor were collected as follows:

Litter fall in September, October 1970 and July, August 1971 from 0.5m² traps located:

- a) under hazel where the litter was a mixture of pine and hazel
- 15 traps in each stand.
- b) outside of the hazel patches where the litter was nearly pure pine - 15 traps in each stand.

^{1/}Assistant Professors of Forestry, Cloquet Forestry Center, College of Forestry, University of Minnesota.

The forest floor samples were collected in October 1970 after all hazel leaves had fallen. The samples, 0.1m^2 , contained all organic matter above mineral soil (L, F and H layers) and were taken within 30 cm of each litter trap.

Branches, parts of cones, etc. over 3-5 mm in diameter were discarded from the samples which were then dried at 80°C for 24 hours and weighed. Total N was determined by micro-kjeldahl on five samples chosen randomly from the 15 samples of litter or forest floor. Other nutrient concentrations were determined for each of the 60 litter and 60 floor samples on a Jarrell-Ash emission spectrograph on duplicate 0.5g sub-samples which were dry ashed. Weights of nutrients in each litter and floor sample were estimated by multiplying sample dry weight by the average of the two nutrient concentration determinations of that sample.

Results:

Weight of Litter and Forest Floor

The 1970-1971 litter fall ranged from 1730 to 3720 kg/ha (Figure). Litter fall under pine plus hazel was 670 kg/ha greater than under the jack pine only and 820 kg/ha greater than under red pine only. The hazel accounted for 28 and 22% of the litter in the jack and red pine stands respectively. This is quite close to Maki's (1950) estimate of 25%. The weight of the forest floor with pine plus hazel was less than that with pure jack or red pine; however, these differences did not exceed the 5% significance level. Had the floor samples been collected in August before litter fall, the forest floor with hazel would presumably have been even less compared to the floor with pure pine. Estimates of litter fall and forest floor weights are comparable to those reported by Alway and Zon (1930) for stands on the same sites.

Nutrient Concentrations in Litter and Forest Floor

Nutrient concentrations were determined on litter which fell under pine plus hazel from September through October 1970, which contained from 30-40% hazel by weight, and on pure pine litter (Table 1). Concentrations of nutrients especially Ca and Mn were higher in the litter containing hazel than in pine litter; most differences were significant (5% level). However, nutrient concentrations in the forest floor were not greater in pine plus hazel except for Ca and Mn. Concentrations of N, P, K and Ca in pine litter are quite close to those reported by Alway and Zon (1930).

Weight of Nutrients in the Litter and Forest Floor

The presence of hazel greatly influenced the weight of nutrients in the 1970-1971 litter. Average weights in both pine and pine plus hazel litter in decreasing order were: $\text{Ca} > \text{N} > \text{K} > \text{P}$, Mg , $\text{Mn} > \text{Al} > \text{Fe} > \text{Cu}$ (Table 2). In both stands weights of all nutrients except Al and Cu were significantly greater (5% level) when hazel was present. In the jack pine stand weights were about double under hazel. In the red pine stand the differences were not as striking.

Unlike the litter, weights of nutrients in the forest floor were not greater under hazel. In both stands the average weights in decreasing order were: $\text{N} > \text{Ca} > \text{K} > \text{P}$, Al , $\text{Fe} > \text{Mg}$, $\text{Mn} > \text{Cu}$. Compared to the litter, N changed places with Ca in the sequence and there were striking increases in Fe and Al. In the weights of nutrients in the forest floor; only Mn in jack pine plus hazel and Al and Fe in pure jack pine were significantly greater (5% level).

Discussion:

The presence of hazel influences the nutrient cycle in pine stands, because under pine plus hazel more nutrients are added to the forest floor than under either jack or red pine alone. The results also indicate that with hazel present the nutrients are rather quickly added to the soil. Even though more nutrients are added annually where hazel is present, they do not accumulate in the forest floor since weights of nutrients in both types of forest floor are about the same (Table 2). Thus with hazel the nutrients appear to move more rapidly into the mineral soil. This reasoning is substantiated by the measurements of litter and forest floor weights (Figure). Although greatest litter fall occurred under hazel, the forest floor weights were less than or equal to those under jack or red pine without hazel. This indicates a more rapid decomposition of the forest floor and release of nutrients. Possibly the greater loss of weight is due to hazel leaves being more easily decomposed than the pine needles, or perhaps the greater nutrient content enables a more rapid breakdown of the total litter.

The weight of litter contributed by hazel in this study (670 and 820 kg/ha) is considered to be representative of relatively dense undergrowths of about 30,000 to 50,000 stems/ha (12,000 to 20,000 stems/acre). However, denser undergrowths are common and can be expected to contribute larger amounts of dry weight and nutrients to the litter. In biomass studies on similar sites in jack and red pine stands with hazel, undergrowths with 80,000 to 90,000 stems/ha (32,000 to 36,000/acre) leaf weights up to 990 and 1600 kg/ha were estimated (Tappeiner and John, 1972).

Additional work is necessary to fully understand the role of hazel in nutrient cycling. Nutrient analysis of the soil is needed to determine if the greater amounts of nutrients in the hazel litter actually become available for plant growth. There may be no effect on the growth of the present overstory and undergrowth, but there may be a long term soil improvement. Also, other undergrowth species may be important in the nutrient cycle. Where hazel is not present in a stand, generally a variety of herbs and some shrubs occur. Although not capable of forming as dense an undergrowth as hazel, collectively these species could add similar amounts of nutrients to the forest floor and release them as rapidly as hazel appears to.

Literature Cited

1. Alway, F. J. and R. Zon. 1930. Quantity and nutrient content of pine leaf litter. *Jour. For.* 28:715-727.
2. Maki, T. E. 1950. Some factors affecting the composition and development of forest floor. Ph.D. Thesis, University of Minnesota, 100 p.
3. Tappeiner, J. C. and H. H. John. 1972. Biomass and nutrient content of hazel undergrowth. Manuscript in preparation.

Table 1. Nutrient concentrations in litter and forest floor under pure pine and pine plus hazel (n = 15).

Sample	Nutrient Concentrations in 1970-1971 Litter								
	N	P	K	Ca	Mg	Al	Fe	Cu	Mn
Jack Pine	.45	.08	.18	.69	.10	600	175	2	849
Jack Pine + Hazel	.60*	.14*	.23*	1.19*	.16*	583	285*	3	1530*
Red Pine	.50	.11	.23	.56	.10	320	198	3	1235
Red Pine + Hazel	.80	.16*	.27*	1.05*	.16*	397*	304*	3	1908*

Nutrient Concentrations in Forest Floor									
Jack Pine	.83	.11	.19	.46	.07	1615	1295	8	570
Jack Pine + Hazel	.84	.12	.18	.70*	.08	1156	867	6	931*
Red Pine	.85	.11	.17	.47	.06	1264	1220	6	749
Red Pine + Hazel	.88	.14	.19	.66*	.08	1281	1240	7	1177

* Nutrient concentrations within jack or red pine (litter or forest floor) with hazel are significantly greater (5% level) than jack or red pine without hazel.

Table 2. Weight of nutrients in litter and forest floor (n = 15).

Sample	Weight of Nutrients in 1970-1971 Litter								
	N	P	K	Ca	Mg _{1/}	Al	Fe	Cu	Mn
Jack Pine	7.8	1.4	3.1	11.9	1.7	1.0	0.3	0.1	1.5
Jack Pine + Hazel	13.2*	3.0*	5.2*	25.0*	3.4*	1.4*	0.6*	0.1	3.2*
Red Pine	14.5	3.2	6.7	16.2	2.9	0.9	0.6	0.1	3.6
Red Pine + Hazel	18.2*	4.1*	7.4*	25.1*	4.0*	1.0	0.8*	0.1	4.8*

Weight of Nutrients in Forest Floor									
Jack Pine	144.3	19.1	33.0	80.0	12.1	28.0**	22.5**	0.1	9.0
Jack Pine + Hazel	122.8	17.5	26.3	102.4	11.7	16.9	12.7	0.1	14.0*
Red Pine	186.0	24.1	37.2	102.9	13.1	27.7	26.7	0.1	16.4
Red Pine + Hazel	152.4	24.2	32.9	114.3	13.9	22.0	21.0	0.1	20.0

^{1/} 1 kg/ha = 1.12 lbs/acre

* Nutrient weights within jack or red pine (litter or forest floor) with hazel are significantly greater (5% level) than jack or red pine without hazel.

** Nutrient weights in jack pine without hazel are significantly greater (5% level) than with hazel.

FIGURE

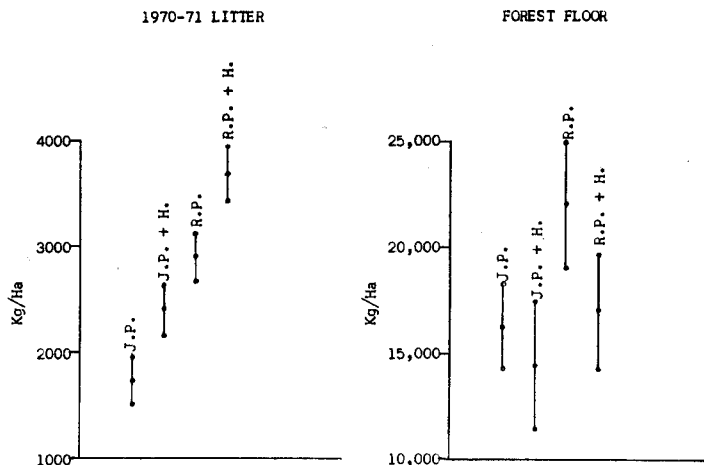


Figure. Means with 95% confidence intervals for dry weight of litter fall (Sept. 70-Aug. 1971) and forest floor (Oct. 1970) under jack pine (J.P.), red pine (R.P.) and hazel (H.). (1 kg/ha = 1.12 lbs/acre)