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NITROGEN MANAGEMENT FOR MALTING BARLEY

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ABSTRACT

Malting barley is a specialized agricultural crop in which high yields and quality are production objectives. We evaluated the effects of different N rates on barley yields and selected malting quality parameters grown on irrigated silt loam soils (Xerollic calciorthids). Maximum barley yields having acceptable malting quality parameters were obtained when the preplant soil NO_3-N plus fertilizer N was between 100 to 120 kg N/ha. About 33 kg N/ha was taken up by the plants from the mineralization of soil organic N. Higher available N levels decreased malting quality parameters below acceptable levels. Germination percentage was not changed by the different N rates.

INTRODUCTION

Malting barley is an important cash crop in the western United States in which the management variables of water supply and N availability largely control yields and malting quality. Nitrogen influences yields, as well as grain kernel size, protein content, and percent germination, which affect malting quality[3,4,7]. Irrigation practices also influence the available N levels, yields and quality[1,8]. The effect of different nitrogen and irrigation cultural practices on the yield and quality of this crop was studied. This paper reports the effects of different amounts of available N on yields and malting quality.

METHODS AND MATERIALS

In 1971 and 1972 the cultivar Moravian VIII and in 1973 and 1974 Moravian III (*Hordeum vulgare* L.) were planted at a rate of 112 kg/ha in irrigated field experiments. The soil in each experiment was a typical Portneuf series (Xerollic calciorthid). These soils have a calcic layer at the 40- to 45-cm soil depth restricting root penetration but not water movement.

A randomized block, split plot design with three replications was used for each experiment, with the soil moisture treatments as the main plots and the N rates as the subplots. Selected amounts of ammonium nitrate (34-0-0) were broadcast on the surface of the subplots and disked 10- to 15-cm into the soil before planting. The N fertilization rate depended upon the experiment and ranged from 0 to 224 kg N/ha. Before N fertilization, the residual soil NO_3-N content was determined by a specific-ion electrode method on soil samples taken to a 61 cm depth. The available N is defined as the residual soil NO_3-N plus the applied N fertilizer.

Two soil moisture treatments were studied, one similar to the conditions reported to be optimum for spring wheat[5] and the other was also similar except that the first irrigation was delayed about one week during the plant's jointing growth stage. This treatment saved about 6 cm irrigation water and reduced straw lengths 10 to 15 cm. These treatments will not be discussed since they did not significantly change the grain protein, plumpness or yields within a given N rate nor was there any significant irrigation by N interactions.

Fifteen to twenty plant tops were taken from each treatment plot at the soft-dough growth stage, dried at 60 C, weighed, ground to pass a 40-mesh seive, and analyzed for total N[2]. Degree of lodging was visually estimated at the firm-dough growth stage, where 0% and 100% indicate no lodging and all plants lying flat, respectively. Grain yields were measured by harvesting a portion of each plot with a conventional grain combine. Kernel plumpness is the percentage by weight of kernels remaining on a 0.238-cm sieve. Grain protein percentages were determined by the Udy dye method (Udy Analyzer Co., P.O. Box 148, Boulder, CO)[11].

RESULTS AND DISCUSSION

Barley grain yields ranged from 2600 to 6600 kg/ha during the four years of this study. The relative grain yields increased as the available N increased from 19 to 120 kg/ha (Fig. 1). Maximum grain yields occurred between 100 and 120 kg N/ha while maintaining acceptable levels for protein (<12%) and plump kernels (>80%). The protein content exceeded 11% and the kernel plumpness dropped below 80% when the available N exceeded 120 kg/ha. Grain from all treatments exceeded 98% germination. There was a tendency for grain yields to decrease at the higher available N levels, possibly because not all the grain was harvested where severe lodging occurred. Lodging severity (>50%) generally increased as the available N increased above 130 kg N/ha.

The grain yields were curvilinearly related to the total N uptake in those treatments having acceptable malting quality parameters (Fig. 2). The total N uptake was also linearly related to the available N, where total N uptake = 32 + 0.52(available N), $r^2 = 0.98$ (except for 1973 when the constant and coefficient were 66 and 0.94, respectively, $r^2 = 0.98$). All the data points above 5400 kg/ha in Fig. 2 are from the 1973 experiment. Separation of residual soil NO_3-N and fertilizer N effects for 1971, 1972, and

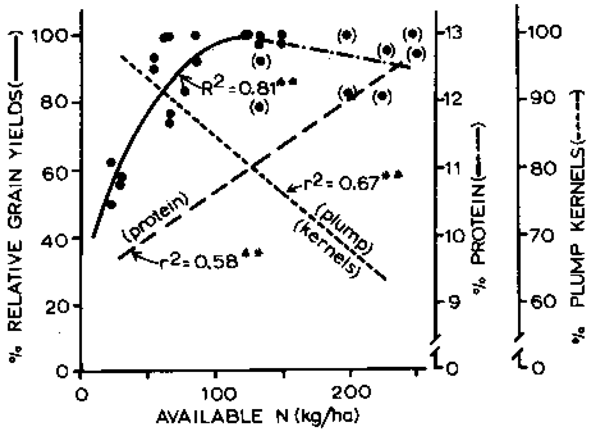

FIG. 1. Relationships of relative grain yield, protein concentration, and percentage plump kernels to available N. (Parentheses show points where barley did not have acceptable malting quality parameters.)

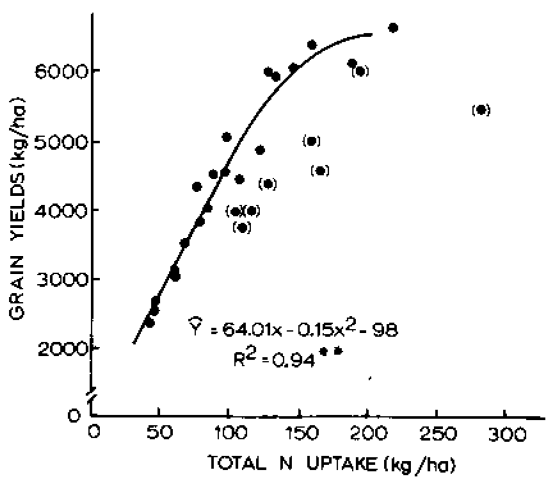

FIG. 2. Relationships between total N uptake in above ground plant materials and grain yields. (Regression equation doesn't include points in parentheses where barley did not have acceptable malting quality parameters.)

1974 gave total N uptake = 34 + 0.47(residual NO_3-N) + 0.52 (fertilizer N), $R^2 = 0.99$.

These data indicate that the recovery of the fertilizer N and residual NO_3-N was between 47% and 52% and that about 33 kg N/ha came from the mineralization of soil organic N sources. Approximately 66 kg N/ha would have been mineralized if similar N recoveries are assumed. About 60 kg N/ha was mineralized from the soil organic N from mid-April to mid-June on similar soils under fallow (unpublished data, D. T. Westermann). Similar fertilizer N recoveries, amounts of N from soil organic sources, and available N requirements have been reported for barley[4,9,10]. Apparent higher recoveries of residual NO_3-N and fertilizer N in 1973 may have resulted from not measuring all the residual NO_3-N and more N being released by the mineralization processes.

CONCLUSIONS

Maximum yields of high quality malting barley were obtained when the residual soil NO_3-N in the 0- to 61-cm soil layer plus the fertilizer N was between 100 and 120 kg N/ha and where the mineralization of soil organic N contributed about 33 kg/ha to plant N uptake. Higher available N levels decreased quality parameters and increased susceptibility to lodging.

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11. Mention of names or companies does not imply endorsement or recommendation by the Department of Agriculture over similar products or other companies not mentioned.