Industrial Hemp Forage Potential

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Abstract

Hemp (Cannabis sativa L.) has been a valuable species for humans throughout history due to its adaptability and diverse uses. Farmers are interested in hemp as a forage and feedstuff due to its unique nutritional properties and fast summer production. Moreover, the presence of cannabinoids in leaf and bud tissues may provide pharmacological benefits to animal health, productivity, and product quality under different regulatory frameworks. This study examined two hemp cultivars, Grandi and Joey, solely as forage crops, and samples were taken at different growth stages in Blacksburg, VA, USA, in 2021. The highest biomass production of 1.41 tons per acre for Grandi and Joey was recorded two months after establishment. The samples taken at different growth stages of Grandi and Joey contained 20 to 31% CP, 24 to 44% NDF, 22 to 38% ADF, and 4 to 9% lignin. These preliminary results suggest that hemp has the potential to be used as a forage crop. However, more research is needed to address hemp management, including field establishment and production management, harvest timing for optimum tonnage and forage quality, and animal intake and performance studies.

Introduction

The recent resurgent interest in industrial hemp (Cannabis sativa L.) has been motivated by the vision of the crop as a key component in sustainable agricultural systems. Hemp historically has been a valuable species to many societies, given its broad adaptation and multiple uses. However, during the 20th century, the crop fell out of favor due to declining demand for and reduced competitiveness of its fiber and because of its relationship to psychotropic forms of the plant (i.e., marijuana). The consequent multi-decade-long divestment in hemp production and research in the U.S. led to a significant gap in basic knowledge of hemp production and management, and relearning has come with some challenges.

The interest in growing hemp in the USA has been increasing since its legalization. However, Researchers are exploring various alternative uses for hemp to establish a sustainable production system. Farmers removing leaves biomass from the floral hemp plant is currently just a waste product. Plenty of spent biomass left over after extracting the flower for CBD oil. These leaves and spent biomass could be an alternative to any other forage like alfalfa. Currently, hemp is not registered feed stalks for livestock. However, in the future, USDA may change the existing rules once scientific findings support the potentiality of hemp as an alternative feed/forage source. Information regarding hemp crop management as forage is limited.

However, the challenge of producing hemp as a forage likely will come from balancing the need to produce substantial tonnage vs. the need for sufficient forage quality. This will be affected by cultivar and management factors such as planting date, seeding rate, fertility, and harvest management. As there is inadequate information regarding hemp as a sole forage crop, this study aimed to determine the forage yield and forage quality of different cultivars at different growth stages.

Methods

Two hemp cultivars representing different growth habits (e.g., Grandi, and Joey) were tested at a field study Located in Blacksburg, Virginia. The seeding rate was 30 lb./acre. The experiment

was a randomized complete block design with split plot arrangements and four replicates. Main plot was the harvesting date, and the sub-plot was the cultivars.

Harvesting was started about three weeks following establishment and continued at one-week intervals. Using a quarter meter-quadrate, whole hemp plants were harvested at 10 cm height from the ground to measure fresh biomass yield. Before each harvest, plant heights were recorded. Fresh biomass was allowed to dry in the drier, and biomass yield was measured using the weight of fresh and dry biomass samples data.

Dried biomass samples of whole plants were ground in a Wiley Mill followed by a Cyclone Mill to produce a sample with a particle size <1mm. Ground samples of the whole plant were scanned in a FOSS NIR Spectroscopy using mixed hay calibration. The measurements of nutritive values included neutral detergent fiber (NDF), acid detergent fiber (ADF), crude protein (CP), and lignin.

The measured data was analyzed in a Python 3.8 environment using the statmodels and scipy.stats libraries. Using ols model ANOVA was utilized to determine the interactions between harvesting time and plant height, biomass yield and nutritive values in the whole plant. The results of the statistical tests were considered statistically significant if the p-value was less than 0.05.

Results and Discussion

Plant height was significant among harvest time and cultivars ($p \leq 0.0001$). The interaction was observed for the cultivars by harvest time. Though at the early growth stage, both cultivars were similar in height. However, plant height was greater for Joey (1.45 m) than the Grandi (1.14 m) at the fourth harvest and after that, plant height remained unchanged (Fig.1) as they were mostly in grain maturation stages.

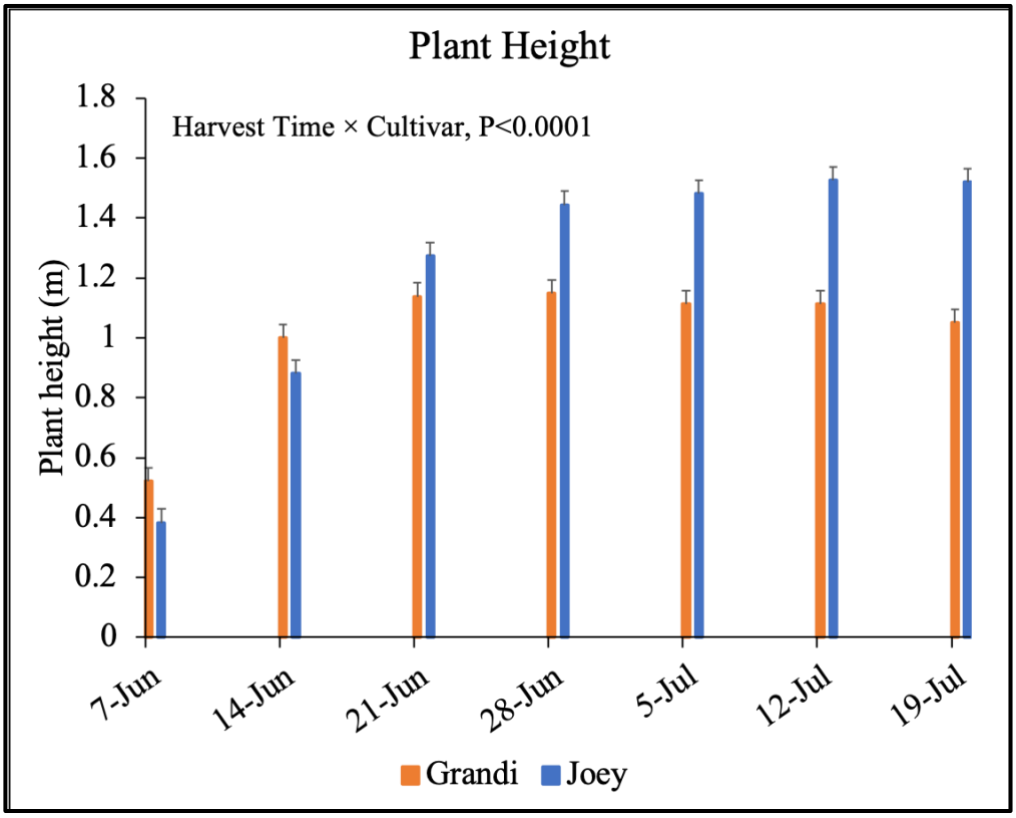

Figure 1: Mean plant height of two hemp cultivars (Grandi and Joey) at different sampling times in Blacksburg, Virginia, in 2021.

Harvesting time was significant for biomass yield ($p \leq 0.0001$). There was no interaction between harvesting time and cultivar for biomass yield (Fig. 2). Biomass yield steadily increased

from the first to the seventh harvest. The highest biomass yield was observed at the seventh harvest (1.29 tons/acre) at the aged of two months old plant.

Harvest date was significant for CP, NDF, ADF, and lignin content ($p \leq 0.0001$) (Fig. 3). CP content was much greater in the first harvest (31.1 %), which was expected because of the higher leaf-to-stem ratio at harvest and the fact that most plants were still vegetative. CP content decreased with the plant maturity as the leaf-to-stem ratio decreased. The lowest CP content (19.75%) was found at the fourth harvest on June 28, 2021. The upward trend of CP at later harvest might be associated with grain formation. NDF and ADF content was much lower in the early stages and increased at later stages. The range of NDF and ADF was 24.89 to 44.37% and 22.47 to 37.63%, respectively, which can be compared with other forage crops. Lignin content was much lower in the early stages and steadily increased with plant maturation. The range of lignin was 4.24 to 9.37 % (Fig. 3).

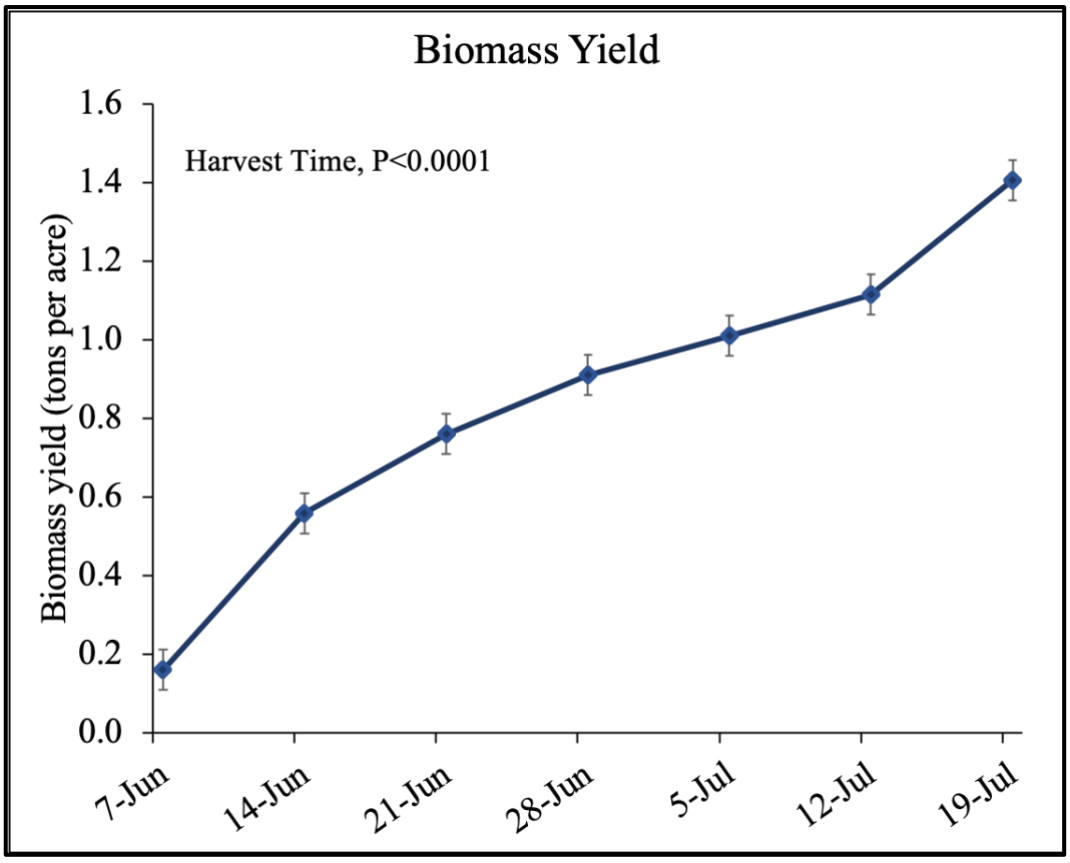

Figure 2: Mean plant height of two hemp cultivars (Grandi and Joey) at different sampling times in Blacksburg, Virginia, in 2021.

This study's results align with previous research on using hemp as a forage crop. In a study by Stringer (2018), significant interactions were observed between planting date and harvest date for CP, NDF, and ADF. Stringer (2018) also found that grain hemp had the highest levels of CP and lowest levels of NDF and ADF, which is consistent with the findings of this study. Additionally, Stringer (2018) suggested that the yields of hemp need to be significantly increased to make it attractive to producers, as the yields were consistently lower and may be uneconomical to produce.

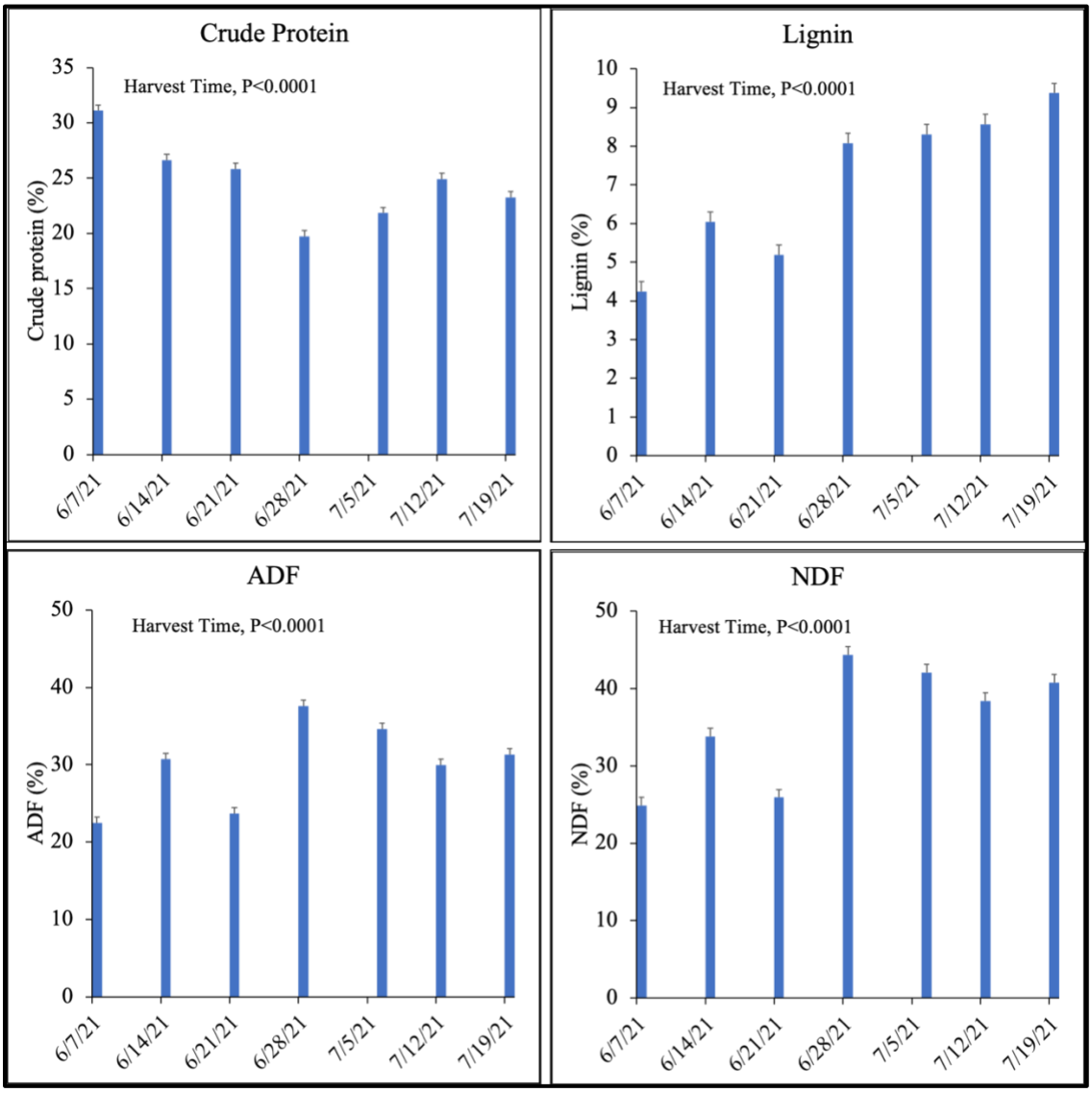

Figure 3: Mean forage quality components in hemp plants averaged across two cultivars (Grandi and Joey) for seven different sampling times in Blacksburg, VA, in 2021.

Conclusions

Hemp plants can provide quality forages when harvested in proper growth stages. However, biomass yield is lower compared to other forages. Grandi and Joey contained 20 to 31% CP, 24 to 44% NDF and 22 to 38% ADF, and 4 to 9% lignin. These results suggest that hemp can be used as a forage crop. Still, significant research efforts will be needed to address hemp management, including field establishment and production management, harvest timing (to optimize tonnage and forage quality), and animal intake and performance studies.

References

Stringer, Carol Elizabeth, "Evaluating Hemp *(Cannabis Sativa)* As A Forage Based On Yield, Nutritive Analysis, and Morphological Composition" (2018). *Theses and Dissertations--Plant and Soil Sciences*. 104. https://uknowledge.uky.edu/pss_etds/104

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