From Forages to Perennial Grain Polycultures: Illinois Bundleflower-Intermediate Wheatgrass Dual Purpose Mixtures

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From forages to perennial grain polycultures : illinois bundleflower-intermediate wheatgrass dual purpose mixtures

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Introduction Perennial grain polycultures are mixtures of herbaceous plants harvested for seed . These food production systems have the ecological advantages of perennial cover and diversity : agriculture modeled after natural grasslands (Natural Systems Agriculture) . Illinois bundleflower [*Desmanthus illinoensis* (Michx .) MacM . ex B .L . Robins . & Fern .] and intermediate wheatgrass [*Thinopyrum intermedium* (Host) Barkworth & D .R . Dewey] are two promising perennial grain species currently being bred for forage and grain production . Illinois bundleflower is a North American native perennial herbaceous warm-season (C4) legume . Intermediate wheatgrass is a cool season grass native to central Europe , with wide adaptation and high forage productivity . Our objective was to determine seed and forage yield of these two perennials in monoculture and binary mixture in central Iowa , USA .

Materials and methods Bundleflower seeds were obtained from the University of Minnesota and derive from two collections in Iowa . Wheatgrass seeds were from the commercial forage cultivar Oahe . Seed density for monocultures of bundleflower was 199 PLS m-2 , and intermediate wheatgrass 239 PLS m-2 ; for each species in mixture density was reduced by half . Each entry was replicated three times in an alpha-lattice design at two locations in Iowa , USA . Seeds were drilled into 4-x 3 m plots in May 2003 . In 2004 each plot was split into two 2-m x 3-m sub-plots : in one forage biomass was harvested three times (May , July , September each year) and removed , while in the other seeds were harvested by hand and removed . The same management was used in 2005 . A single 1x 3 m strip was harvested for biomass with a flail-type harvester . Reproductive structures of bundleflower and intermediate wheatgrass were hand harvested from the entire sub-plot area as each species matured (wheatgrass seeds on late July , bundleflower seeds on early September) . Seed yield and forage yield were subject to analysis of variance using a mixed linear model that included locations , replications within location , incomplete blocks within replication , entry (main plot) , and year (split-plot) . Orthogonal contrasts were used to compare monoculture means between years and entry means against each monoculture . Statistical significance was assessed at the 5% probability level .

Results Wheatgrass produced its largest seed yield in the second year after seeding (65 .8 ± 6 .5 g m^{-2}) , whereas bundleflower seed did so in the third year (55 .0 ± 8 .1 g m^{-2}) . The mixture comprising both perennial grains produced as much seed as the best yielding monoculture each year . Crude protein concentration in seed was 411 ± 8 g kg^{-1} for bundleflower and 150 ± 3 g kg^{-1} for wheatgrass . In the forage , crude protein concentration was 165 ± 5 g kg^{-1} for bundleflower and 112 ± 5 g kg^{-1} for wheatgrass , averaged over all three forage harvests , years , and locations . Protein yield of the mixture was no different than the highest protein yielding monoculture . The mixture was less variable than each monoculture between years and provided a sort of insurance : while each monoculture yielded well in one year and poorly in the other , the mixture always yielded as high as the best monoculture each year . Total forage yield of the mixture was lower than the highest yielding monoculture (wheatgrass) , higher than the lowest yielding monoculture , and no different from the average of the monocultures . Protein concentration in the mixture of seeds and of the combined forage was also intermediate between both monocultures .

Conclusions While protein content of perennial grains is high , seed yields need to be improved in order to reach yields comparable with annual grains . However , these improvements are within the range of yield gains already achieved with annual grains in the last 50 years by agronomic management and plant breeding . Apart from increasing yields , breeding efforts should be focused on developing compatible mixtures , with high competitive ability against weeds . Future research should focus on breeding and management of crop mixtures to minimize competition among crops while maximizing weed suppression .