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FINAL STUDY REPORT
(Cape May PMC, Cape May Courthouse, NJ)

Interplanting of Native Legume Amberique-Bean (*Strophostyles hevola*) with Beachgrass (*Ammophila breviligulata*) in Hoop House Study to Increase Diversity and Improve Resilience in Coastal Dune Plantings along the Mid-Atlantic Coast

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ABSTRACT

INTRODUCTION

'Cape' American beachgrass (*Ammophila breviligulata*) has been widely and affectively used as the standard plant material for dune stabilization application in the Northeast for several generations. Although there are efficiencies in using well-known and widely-available plant materials for immediate stabilization solutions, monocultures of American beachgrass have typically lacked diversity and species richness associated with successional sequences found in natural formed dune systems. This study's purpose is to determine the advantages and disadvantages of growing two accessions of amberique-bean (*Strophostyles helvola)* with American beachgrass to determine potential positive synergistic effects between legume and grass dune mixtures.

Coastal dune ecosystems are often seen as marginal land with too few species resilient enough to provide ecosystems services beyond those of a recreational nature. Yet, coastal ecosystems are dynamic systems that are in a constant state of flux, thus opening up many pathways for seed recruitment and the introduction of a diverse plant communities in various states of succession. Beyond their immediate structural and architectural contributions to dune stabilization, coastal plant communities also play a critical function in providing food, shelter, and nesting sites for a range wildlife including of Neotropical migratory birds, especially along the shoreline of the Mid-Atlantic region.

Many monotypic dune plantings using 'Cape' American beachgrass are established with recommendations of fertilization for good stand establishment and to improve stand vigor. These recommendations call for 30–60 lb/N/ac annually and are split into equal spring and early summer applications. This split application is designed to follow the growth curve and seasonal N demands of the plant. It is not certain whether a native legume such as *Strophostyles helvola* can fix the required N to meet the annual growth needs of beachgrass. Yet, it is well-known that many grass/legume mixes can fix N for associate grasses, help optimize the use of light, water, soil, and space, and have many beneficial mutual associations that support increase ecosystem resilience. While this hoop house study will only test to see the nature of the grass/legume interaction in isolation, a simultaneous study will be set up in situ in a freshly dredged dune in Avalon, NJ for anecdotal comparison.

Amberique-bean (*Strophostyles helvola*) is a reseeding, warm-season annual native legume that grows on coastal foredunes, backdunes, roadsides, and abandoned fields. Two accessions of amberique-bean are used in comparison, an "early blooming/seeding" (47142) and "late blooming/seeding variety" (43918). Both accessions came from the archived collection at the USDA-NRCS Cape May PMC, Cape May, NJ and were field tested and observed in 2013 for seeding times, vigor, and seed production.

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MATERIALS AND METHODS

Site Location The location for the study was the USDA-NRCS Cape May Plant Materials Center, in Cape May County, NJ (hoop house). The mean annual precipitation of the area is 28–59 in. and the mean annual air temperature is 46–79° F.

Methods There were four 5x8 row complete randomized blocks with 4 treatments each installed in early spring 2014 (4/10–4/11). The treatments were: amberique-bean 47142 and 43918, fertilizer, and control. On 4/10/14, scrap paper fill was placed in the bottom of each 1 gallon pot (total 160 pots), and filled with sand. One cleaned beachgrass stem was planted 5” deep per pot and arranged in 4 completely randomized blocks in the PMC hoop house. On 4/11/14 four seeds of amberique-bean were planted in each pot 40 mm deep in 4 quadrants of approximately equal distance from beachgrass stem. Fertilizer treatment was 10 g of 14-14-14 slow release fertilizer placed into a tablespoon-sized shallow hole pressed into sand, all on one side (west side) of plant. All fertilizer applications were placed on a single side of the plant rather than evenly distributed to test if there was a difference in root development with site of fertilizer application. Pots where then topped off with sand and stems cut to 15 cm above top of the gallon pots. Irrigation in the hoop house was set for 1 period/day (80 min) in the early morning. Amberique-bean seedlings were thinned (destroyed) until there was only one living amberique-bean per beachgrass stem per pot. A total of 23 beachgrass plants were dead at 25 DAP and were replaced with live stems.

Sampling Method The attributes measured were: planting date, date of emergence, beachgrass (stem count, stem width, stem height, seed head presence, seed head length, root dry weight, culm and leaf dry weight); amberique-bean (emergence date, stem width, stem length, root length, root dry weight, nodule count, location, and activity, leaf count, leaf length, leaf width, bloom count, seedpod count, number and length of seedpod, number of seeds) for both amberique-bean accessions.

The first measurement was taken on 05/09/14; 28 DAP. Subsequent sampling took place every 14 days. There was a total of 12 sampling dates.

List of Sampling Dates

05/09	05/23	06/06	06/20	07/04	07/18
08/01	08/15	08/29	09/12	09/26	10/10

RESULTS AND DISCUSSION

Amberique-Bean Both accessions of amberique-bean ‘3918’ and ‘7142’ had similar germination rates at 81% and 82% respectively. The initial emergence and growth of accession ‘3918’ was noticeably delayed by approximately 1.5 weeks when compared to ‘7142’. When grown in association with beachgrass, there were significant differences between the leaf count and root length of the two accessions of amberique-bean (Table 1). Accession ‘3918’ had greater leaf production and a deeper root system (overall greater vigor). However there were no significant differences in the following: leaf length, leaf width, nodule count, nodule activity, nodule size, seed length, seed width, seedpod count. Overall, these differences between accessions may have been statistically significant, but they did not make a noticeable difference in overall growth of the beachgrass plant.

Table 1. Amberique-bean leaf count and root length (cm).

Leaf Count and Root Length (cm)

Treatment	Leaf Count	Root Length (cm)
Sthe '3918'	23 a	49 a
Sthe '7142'	13 b	42 b

[1/] Means in column followed by the same letter are not significantly different according to Tukey's HSD at $P<0.05$.

Table 2. Amberique-bean height, nodule count, and leaf count at early thinning (5/19/14).

Amberique-Bean Height, Nodule and Leaf Count

	Height (cm)	# Nodules	Leaves
Sthe '3918'	11.3	9	3
Sthe '7142'	10.8	11	4

Amberique-bean x American Beachgrass Interaction There were significant differences in beachgrass root length in amberique-bean treatments and control compared to beachgrass with fertilizer treatment (Table 3). This would suggest that there was no statistical advantage to root length by planting amberique-bean over growing beachgrass without the legume (control). The data suggests that the addition of fertilizer to containerized plants negatively influences root development. Providing readily available nutrients to beachgrass roots may be encouraging slower, "lazier" roots that essentially don't need to grow to reach nutrients. It is unknown whether or not a similar situation exists in beachgrass dune plantings that are also fertilized in situ.

Both the number of beachgrass stems and the stem height were significantly increased by the addition of a fertilizer treatment. Conversely, there was no noticeable effect to the number of stems or stem height with the addition of amberique-bean. American beachgrass grown in association with amberique-bean '7142' had a significantly greater root dry weight when compared with amberique-bean '3918' and the control (Table 3). However, the significance of the interaction appears to be mainly statistical, as every other growth parameter of the beachgrass did not benefit (improve), and is still significantly lower than the fertilizer treatment (Fig. 1).

The presence of amberique-bean only seems to have a significant effect on the number of beachgrass seedheads produced (Table 5). There were no beachgrass seedheads in the control treatment, and only six produced in the fertilizer treatment. In the presence of amberique-bean however, there was a significantly greater number of seedheads produced. While it remains unclear why this interaction should occur, it is not significant or beneficial in a practical sense as American beachgrass spreads mainly through tiller increase and spread.

Table 3. American beachgrass root length and dry weight, stem height, stem width, and stem number when grown in association with amberique-bean.

		American Beachgrass Root and Shoot Attributes				
Treatment	**Treat #**	**Root Length (cm)**	**Root Dry Weight (g)**	**Stem Height (cm)**	**Stem Width (mm)**	**Stem Number**
Amberique-Bean #9047142	2	49.83 a	16.75 a	72.08 b	5.31 a	2 b
Control- No Fertilizer	4	46.24 a	10.75 b	65.70 b	5.22 a	1 b
Amberique-Bean #9043918	1	44.56 a	9.5 b	68.43 b	5.14 a	2 b
Beachgrass + Fertilizer	3	35.27 b	–	95.97 a	4.93 a	17 a

1/ Means in column followed by the same letter are not significantly different according to Tukey's HSD at $P<0.05$.

As most perennial grasses do not produce seeds during the first year of establishment, it was surprising to find that a significant number of seed heads were produced during this one season study. A potential cause for seed head development in amberique-bean enriched pots could be that the beachgrass underwent additional stress as a result of being grown together with amberique-bean. As adequate moisture was provided daily throughout the study, it is unlikely this stress was the result insufficient soil moisture. Nevertheless, the association between the two plants grown together in this study appears to have caused stress to the beachgrass plants and encouraged the grass to put its energy into seeds as a survival response. An interesting possibility is that the seed head development in the beachgrass could be due to a lack of nitrogen in the study pots. This could be caused by the N requirements of the amberique-bean; which resulted in N depletion rather than N addition to the beachgrass root zone. Rather than sharing resources in a positive symbiotic relationship, beachgrass and amberique-bean appeared to compete for limited resources; most likely N.

Table 4. American beachgrass culm and leaf dry weight (g) when grown in association with amberique-bean.

American Beachgrass Culm and Leaf Dry Weight (g)		
Treatment	**Treatment Number**	**Mean (g)**
amberique-bean #9047142	2	52.25 a
amberique-bean #9043918	1	42.25 a
Control- No Fertilizer	4	36.25 a

1/ Means in column followed by the same letter are not significantly different according to Tukey's HSD at $P<0.05$.

Table 5. American beachgrass seed head presence when grown in association with amberique-bean.

Number of American Beachgrass Seed Heads		
Treatment	**Treatment Number**	**Total Number of Seed Heads**
Amberique-Bean #9043918	1	15 a
Amberique-Bean #9047142	2	12 a
Beachgrass + Fertilizer	3	6 ab
Control- No Fertilizer	4	0 b

[1/] Means in column followed by the same letter are not significantly different according to Tukey's HSD at P<0.05.

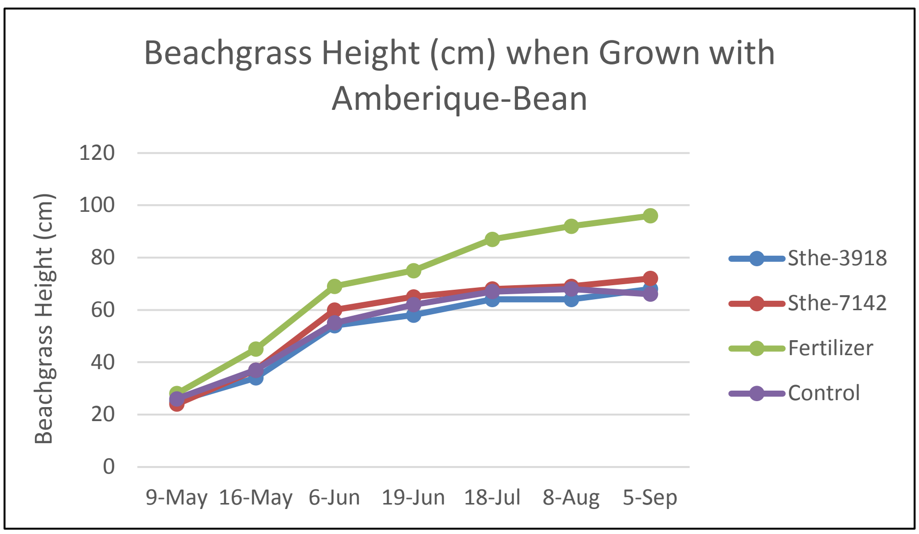

Figure 1. Beachgrass height (cm) when grown with amberique-bean in shade house pots from May to Sept. 2014.

CONCLUSION

There are many factors that affect potential N-fixation and uptake in legume/grass mixes. The soil type, species, number of species in the grass and legume intercropping, and the relative abundance of grasses and legumes are just a few. In this experiment potential opportunities for N-fixation seemed well-suited for sandy substrate in containerized plant production due to the naturally low N-content of the sandy soil used as a root medium. However, results from this one-year, exploratory hoop house study indicate that there was no advantage in growing two accessions of amberique-bean with American beachgrass. In fact, rather than exhibiting a positive symbiosis between functional groups, this study suggested that resource competition for N resulted in an adverse, or negative symbiosis. Although the native legumes in this study were not treated with bacterial inoculants (*Strophostyles* specific inoculant), nodule counts and dissection during this study revealed active nodulation present in both accessions of amberique-bean. Therefore, caution should be applied when designing dune restoration seed mixes with multiple species and multiple functional groups. In N-limited environments like dune ecosystems, the negative effects of resource competition between plants for both water and N could outweigh the potential benefits gained from greater species diversity. In other words, species diversity may not increase ecosystem resilience.

Nevertheless, the combination of a legume and grass in dune restoration mixes could provide a combination of beneficial effects (positive symbiosis) that go beyond simple fertilization and N-fixation effects. For example, wind erosion and sand deposition have large influences on the long-term condition of dunes and the composition of dune communities. The need for fresh sand accumulation on beachgrass stems is well-known, but less well-known are the effects that a climbing nurse plant like amberique-bean might have on trapping beneficial wind-blown sands. In this potential scenario, beachgrass would provide the needed structural support for the climbing legume while the leaves of the legume would trap fresh sand needed by beachgrass. Future studies in situ may focus on the structural interface between beachgrass and amberique-bean and the effects of sand deposition on stand health and longevity.

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