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The Basics to Winter Cover Crop Considerations for Arizona Growers

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1. Introduction

Cover cropping is essential for sustainable crop production. These cover crops can be used as a single species or a mix of species. The main purpose of cover cropping in desert environments is to cover the soil, protecting the rich topsoil by introducing a layer of protection against eroding agents like wind. A growing cover crop can also use residual soil nutrients (nitrate-nitrogen), protecting our environment from pollution like nitrate in water or greenhouse gas emissions, as excess nitrogen can become gases like nitrous oxides). Rarely, cool season cover crops can catch off-season winter precipitation as well through improved infiltration facilitated by their root systems, bolstering soil health. Producers can reap other benefits from cover cropping as well, such as integrating crop diversity, improving soil fertility by fixing additional nitrogen (legume cover crops can fix nitrogen through Rhizobia symbiosis), and providing off-season hay for livestock (grazing or baled/green chop hay). Overall, cover crops can be custom-designed to fit a farm's goals and maximize soil health and economic benefits.

Cover Crops in Desert Southwest

In Arizona and the larger desert Southwest, single-species cover crops are generally used. Barley is one of the major winter cover crops used in rotation with a summer cash crop, while triticale and winter wheat are also popular. Traditionally in Arizona, a high seed rate of greater than 100 lbs/acre is used for grassy cover crops to sell the cover crop biomass as hay. These cover crops also require irrigation often exceeding than 2 acre-feet/acre, similar to a cash crop. Cover crops should utilize existing fertility and moisture following a cash crop, requiring minimal-to-no input or maintenance. Therefore, a cover crop mix may be ideal for desert environments (Figure 1), which provides multiple soil health benefits (crop diversity, nitrogen fixation if legume crops are included, compaction mitigation if root crops like radishes and turnips are included) and ensures soil cover with a lower seeding rate of around 50-60 lbs/acre, and less than an acre-foot/acre of irrigation (Sanyal et al., 2023). Cover crop mixes also work well for challenging soils impacted by salts or compaction, as planting multiple species reduces the chance of crop failure when one or two species fail to germinate due to environmental stresses like moisture or salinity.

Figure 1: A cool season cover crop mix (fava beans, oats, winter wheat) was grown following sorghum (hay crop) in Glendale, AZ

Winter Cover Crop Options for Arizona

The majority of farms in Arizona have alkaline (pH >7.5), and saline (electrical conductivity > 1.0 mmhos/cm) soils; therefore, many plant species, especially legumes, cannot germinate or grow. Because of these conditions, winter cover crop options for Arizona (Table 1) are somewhat limited. The cover crop species can be categorized broadly into two groups based on plant physiology: grass-types or legumes, and broadleaf-types or brassicas. While grasses like barley, rye, and winter wheat are mostly used to produce a large carbon-rich biomass to sequester carbon

Table 1. A list of cover crop species that are suitable to grow in Arizona during winter season

Grasses	Broadleaves
Barley (*Hordeum vulgare*), Oats (*Avena sativa*), Winter Wheat (*Triticum aestivum*), Annual Rye (*Secale cereale*), Triticale	Fava Beans (*Vicia fava*), Vetch (*Vicia spp.*), Clover (*Trifolium spp.*), Mustard (*Brassica spp.*), Canola (*Brassica napus*), Turnip (*Brassica rapa*), Radish (*Raphanus sativus*)

and scavenge on residual fertilizers from the previous crop, legumes like fava bean (bell bean or broad bean), vetch, winter pea, and clover can fix atmospheric nitrogen, improving soil fertility (Figure 2). Brassicas like canola and mustard or rapeseed can reduce soil pathogens through allelopathic root exudates, meaning the chemicals released from their root systems hinder the growth or survival of soil pathogens (Biswas et al., 2014). Radishes and turnips can help reduce compaction with their large, modified roots (Cofer et al., 2019; figure 2).

Two major differences between grass-type and broadleaf-type cover crops are (i) the amount of biomass produced, and (ii) the time required to decompose the cover crop biomass and release nutrients. Grass-type cover crops produce a larger biomass if they can access adequate water and nutrients, and their residues decompose more slowly compared to broadleaves; this is due to the higher carbon and lower nitrogen content of grassy residue biomass (Finney et al., 2016). Therefore, choice of winter cover crop or composition of a cover crop mix should be determined based on the crop rotation (such as previous crop harvest time, next cash crop planting time) and climate (such as local temperature, humidity, and precipitation) must be considered. One must also ensure conditions for cover crop residue decomposition, such as granting adequate time for optimum cover crop residue biomass production and composition, which allows for the release of the nutrients tied up in the cover cop biomass for the next cash crop in rotation. Winter cover crops should also be chosen based on the summer season cash crop in rotation. For grassy cash crops like corn, sudangrass, and sorghum, cover crop mixes with more broadleaves should be selected, with a grass-broadleaf ratio around 40:60 by weight. Similarly, for broadleaf cash crops like cotton, use more grass-type cover crops in the mix with a grass-broadleaf ratio around 70:30 by weight, or a single-species grass cover crop. This grass and broadleaf species growing in rotation will introduce maximum crop diversity, as well as associated benefits like optimum decomposition of residues and nutrient cycling in the ecosystem. This will help restore natural resources and maintain soil microbial diversity (Chapagain et al., 2020).

For single-species cover crops, grass-type cover crops should be chosen to ensure adequate biomass and maximum cover cropping benefits (Figure 3). Most legume cover crops do not do well under saline soil conditions, while brassica species like canola and mustard or rapeseed are drought and salinity tolerant but produce little biomass. However, a combination of grass and broadleaf-type cover crop species is generally considered best for soil health, having multiple benefits like nitrogen addition, alleviation of soil compaction, soil borne pathogen control, and increased soil aggregation, on top of the benefits to ecosystem diversity with multiple species growing on the same piece of land (Figure 3). This mixing of different plant species can also help achieve an optimum biomass, both in amount and composition, which can breakdown in time for the next crop and provide green manuring benefits. Additionally, in our preliminary studies we have noticed that when legumes like alfalfa and fava bean are grown with grasses like rye, barley, and winter wheat, the growth is faster for both type of crops. However, seed rates in a grass and broadleaf mix is crucial, as a high grass seed rate can be detrimental to broadleaf germination; therefore, a minimum of one-third of the seeds by weight in a seed mix should be broadleaves to gain any effect of broadleaves. Too much broadleaves, typically around 70% of seed weight, are also impractical, as the biomass production will be lesser and the residue will decompose too fast to be able to achieve benefits like carbon sequestration or residue mulch, which can act as a 'soil armor.'

Figure 2. Legumes like fava beans can fix atmospheric nitrogen in root nodules while radishes can produce large modified roots and break compacted soil layers

Figure 3. A cover crop mix with equal proportions of grasses and broadleaves (left) and a rye cover crop seeds (right) for solo planting

Establishment of Winter Cover Crops

The ideal time to plant winter season cover crops is late November to early December, which provides some initial warm days to germinate the seeds and may benefit from some precipitation during late December. Generally, one irrigation of about 4-6 acre-inches/acre just after planting of winter cover crop is adequate if a little precipitation is received during winter. Otherwise, a second irrigation of about 4-6 acre-inches/acre in late January may be crucial for cover crop establishment and for the production an optimum biomass. Winter season grasses like barley, oats, wheat, and rye can be used as cover crops-cum-supplemental forage crops as they produce a large biomass, however a high seed rate of around 80-100 lbs/acre is recommended. In our trials conducted, we used a seed rate of 25-30 lbs/acre for green manuring purposes, meaning the resulting cover crop biomass is incorporated into topsoil following cover crop termination. 50-60 lbs/acre may be necessary for grazing cover crops, and 60-75 lbs/acre is necessary for cover crop-cum-forage crop, which are to be sold as forage and animal-feeds; these seed rates were used for a cover crop mix with equal proportions (grass-broadleaf ration 50:50 or 60:40) of grass and broadleaf-type cover crop seeds.

Cover crops are essential tools with multiple benefits and are important to maintain soil health and productivity. Although no additional benefits such as yield improvement is guaranteed, cover cropping can help restore soil resources and fertility, and provides a protective barrier against wind erosion in desert environments of Arizona. Therefore, cover crops are crucial for sustainable agriculture and ecosystem health.

For additional reading on cover crops, check out these resources:

- https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az2084-2024.pdf
- https://extension.arizona.edu/sites/extension.arizona.edu/files/attachment/CoverCrops_0.pdf
- https://www.nrcs.usda.gov/plantmaterials/azpmcsr13597.pdf
- https://www.nrcs.usda.gov/plantmaterials/natpmtn13595.pdf
- https://easternazlivestockandag.com/?p=828

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References

Biswas, P. K., Morshed, M. M., Ullah, M. J., & Irin, I. J. (2014). Allelopathic effect of Brassica on weed control and yield of wheat. Bangladesh Agronomy Journal, 17(1), 73-80.

Chapagain, T., Lee, E. A., & Raizada, M. N. (2020). The potential of multi-species mixtures to diversify cover crop benefits. Sustainability, 12(5), 2058.

Cofer, T. L. (2019). Radish Cover Crop Growth and Compaction Alleviation Potential in Southeastern Coastal Plain Soils [Master's thesis, Auburn University]. Auburn University Electronic Theses and Dissertations.

Finney, D. M., White, C. M., & Kaye, J. P. (2016). Biomass production and carbon/nitrogen ratio influence ecosystem services from cover crop mixtures. Agronomy journal, 108(1), 39-52.

Sanyal, D., Stackpole, C., & Megdal, S. B. (2023). Evaluating Forage Cover Crop Mixes for the Desert Southwest. The University of Arizona Cooperative Extension. Publication number: AZ 2062-2023. http://hdl.handle.net/10150/671181

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