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Pectins are the most complex polysaccharides of the plant cell wall. Based on the number of methylations, acetylations, and glycosidic linkages present in their structures, it is estimated that up to 67 transferase activities are involved in pectin biosynthesis. Pectic galactans constitute a major part of pectin in the form of side chains of rhamnogalacturonan-I. In Arabidopsis, Galactan Synthase 1 (GALS1) catalyzes the addition of galactose units from UDP-Gal to growing β-1,4-galactan chains. However, the mechanisms for obtaining varying degrees of polymerization remain poorly understood. In this study, we show that AtGALS1 is bifunctional, catalyzing both the transfer of galactose from UDP-α-d-Gal and the transfer of an arabinopyranose from UDP-β-l-Arap to galactan chains. The two substrates share a similar structure, but UDP-α-d-Gal is the preferred substrate, with a tenfold higher affinity. Transfer of Araβ to galactan prevents further addition of galactose residues, resulting in a lower degree of polymerization. We show that this dual activity occurs both in vitro and in vivo. The herein described bi-functionality of AtGALS1 may suggest that plants can produce the incredible structural diversity of polysaccharides without a dedicated glycosyltransferase for each glycosidic linkage. This article is protected by copyright. All rights reserved.