zebra7 and luteus17 are allelic to lemon white1.

--Stinard, PS and Sachs, MM

Based on map location, function, and predicted phenotype, Stinard (2013 MNL 86:29-31) hypothesized that the maize lemon white1 (lw1) locus encodes the plastidial (MEP pathway) isoprenoid biosynthetic enzyme HMBPP reductase (HDR), associated with gene model GRMZM2G027059 on chromosome 1L. Using a map-based cloning approach, Lu et al. (2012. Molecular Plant 5:1100-1112) associated HDR with the zebra7 (zb7) locus, also on 1L. Presumably due to their divergent mutant phenotypes, no allele tests between lw1 and zb7 have been reported. In order to resolve the discrepancy between the loci associated with HDR, we conducted tests of allelism between lw1 and zb7, and also included the 1L mutants l17 and w18 in our tests due to their map locations in proximity of lw1. It should be noted that l17 mutants are also associated with lemon endosperm, but zb7 and w18 mutants are not.

Plants heterozygous for lw1, l17-N544, and w18-N495A were crossed to plants heterozygous for zb7-N101. The progeny kernels from these crosses were planted in sand benches and the resulting seedlings scored for mutant phenotypes. Crosses of lw1 and l17-N544 heterozygotes to zb7-N101 heterozygotes segregated for zebra seedlings (Figures 1 and 2). Crosses of w18-N495A heterozygotes to zb7-N101 heterozygotes resulted only in green nonmutant seedlings (data not shown).

In order to rule out the possibility of nonallelic noncomplementation between zb7-N101 and lw1, zebra plants from the allelism test cross between these two mutants were grown to maturity in the field and self-pollinated. These doubly heterozygous zb7-N101/lw1 plants were also crossed to plants heterozygous for l17-N544 in order to provide additional phenotypic data. Seeds from these selfs and crosses were planted in the sand bench and the resulting seedlings were scored for mutant phenotypes. All seedlings from the selfs of doubly heterozygous zb7-N101/lw1 plants were either zebra or albino—no green seedlings resulted (Figure 3). We conclude that zb7-N101 and lw1 are mutants at the same locus. Crosses of the doubly heterozygous zb7-N101/lw1 plants to l17-N544 heterozygotes resulted in ears giving rise to seedlings segregating for luteus (presumable l17-N544/lw1 heterozygotes), zebra (presumable l17-N544/zb7-N101 heterozygotes), and green (heterozygotes for the nonmutant L17 allele; Figure 4). These data provide additional confirmation of the allelism of all three mutants. Since the lw1 locus name has precedence in the literature (Tulpule, SH. 1954. Am J Bot 41:294-301) vs. zb7 and l17 (Neuffer, MG and Beckett, JB. 1987. MNL 61:50), we propose that the lw1 locus name be retained, and zb7 and l17 mutant alleles be renamed as alleles of lw1.
Figure 1. Seedlings from the cross of a $zb7-N101$ heterozygote by a $lw1$ heterozygote, alongside homozygous $zb7-N101$ and $lw1$ controls. Left: $zb7-N101/lw1$ double heterozygotes. Middle: $zb7-N101$ homozygotes. Right: $lw1$ homozygotes.
Figure 2. Seedlings from the cross of a zb7-N101 heterozygote by a l17-N544 heterozygote, alongside l17-N544 control. Left: zb7-N101/l17-N544 double heterozygotes. Right: l17-N544 homozygotes.
Figure 3. Seedlings from the self pollination of a \textit{zb7-N101/lw1} double heterozygote. Zebra seedlings on the left were grown from yellow kernels. Albino seedlings on the right were grown from lemon kernels.
Figure 4. Seedlings from the cross of a $l17$-$N544$ heterozygote by a $zb7$-$N101/lw1$ double heterozygote. Green (presumed $L17$ heterozygote) and zebra (presumed $l17$-$N544$/$zb7$-$N101$ double heterozygote) seedlings on the left were grown from yellow kernels. Luteus (presumed $l17$-$N544/lw1$ heterozygote) seedlings on the right were grown from lemon kernels.