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US-1136, US-1137, and US-1138 Cowpea Lines for Cover Crop Use

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US-1136, US-1137, and US-1138 are new cowpea lines with vigorous, indeterminate growth habits that were released by the Agricultural Research Service of the U.S. Department of Agriculture in 2010 and are recommended for use as a cover crop. Cowpeas are valued as a summer cover crop (Clark, 2007), because they thrive in hot moist environments, grow well in low-fertility soils, and their vigorous growth smothers weeds. They can fix up to 220 kg·ha^{-1} nitrogen and are an excellent source of nitrogen for fall-planted crops. Resistance of cover crop cultivars to soilborne diseases is necessary to avoid increasing populations of pathogens and plant–parasitic nematodes that induce disease in rotational crops. Many indeterminate cowpea genotypes produce seeds with impermeable seedcoats (hard seeds). The major attributes of lines US-1136, US-1137, and US-1138 have rapid growth, high biomass production, a long vegetative growth period, and southern root knot nematode [*Meloidogyne incognita* (Chitwood) Kofoid and White] resistance, and they do not produce seeds with impermeable seedcoats.

Origin

Lines US-1136, US-1137, and US-1138 were produced from landrace populations using a pure line selection procedure. In 1997, field screening trials were initiated to identify cowpea genotypes suitable for use as a cover crop. The 47 entries in the initial studies included cultivars, germplasm accessions, and landraces, all selected for indeterminate growth. After the preliminary field studies were completed, 11 populations were selected for more detailed evaluation. After 3 additional years of evaluation (2002–04), eight of the 11 populations were eliminated as a result of poor seed production or quality, production of seeds with impermeable seedcoats, or disease susceptibility. The remaining three populations, landrace population Hardee (USVL Accession 698), landrace population Graham #1 (USVL Accession 697), and landrace population Tyler (USVL Accession 735), proved well suited for use as a cover crop. All three populations are heterogeneous landraces that were collected in South Carolina. Because the three landrace populations were considered too heterogeneous for release, a pure-line selection procedure was initiated to develop homogeneous lines. In 2005, the landrace populations were grown in a field planting and three vigorous plants from each population were selected. In a 2006 field planting, the original three landrace populations and the progenies of the three plants selected from each of the original populations were carefully evaluated for the following traits: rapid growth, good vigor, indeterminate growth habit, and high seed quality. A single progeny population was selected from each of the original landrace populations as a germplasm line. Lines US-1136, US-1137, and US-1138 were selected from the landrace populations Hardee, Graham #1, and Tyler, respectively. In 2007, each of the candidate germplasm lines was planted in two separate field plantings. The purpose of the first planting was to collect detailed descriptor information and measure plant growth characteristics, and this replicated experiment was repeated in 2008 and 2009. The purpose of the second planting was to harvest breeder's seed of US-1136, US-1137, and US-1138.

Description

Harrison et al. (2006) evaluated each of the original three landrace populations for use as a cover crop. They reported that each of these populations has a vigorous, relatively upright growth habit when grown at conventional plant spacing and is a high biomass producer. They also reported that the indeterminate plant habits of the landrace populations were more competitive against weed populations than the determinate plant habit typical of a horticultural-type cowpea cultivar, Charleston Greenpack.

US-1136, US-1137, and US-1138 have relatively short photoperiods; flowering does not begin until daylength is ≈13 h, and flowering and pod set continue in an indeterminate manner until plants senesce in late fall or are killed by frost. The lines are homozygous for all important agronomic traits. They are resistant to the southern root knot nematode [*Meloidogyne incognita* (Chitwood) Kofoid and White] (Table 1) (many horticultural cultivars are susceptible), grow well without nitrogen fertilization, and are well adapted to the hot, wet summer climate typical of the southeastern United States. Many indeterminate cowpea genotypes, including the commonly grown cover crop cultivar, Iron Clay, produce seeds with an impermeable seedcoat. This trait enables viable seeds to overwinter in the soil, germinate in subsequent growing seasons, and become a weed in rotational crops. The newly released lines produce good-quality seeds with high germination rates (greater than 95%) and do not produce seeds with impermeable seedcoats.

A replicated experiment was conducted in 2007, 2008, and 2009 to measure the growth of cowpea plants unrestricted by competition. The soil was a Yonges fine silty sand (Typic Endoaqualfs) and was not fertilized. The results demonstrated the long growth period and extensive growth of the indeterminate cowpeas in comparison with the determinate,

Table 1. Response of cowpea genotypes to southern root-knot nematode, *Meloidogyne incognita* race 3 in a greenhouse assay.

Genotype	Egg number[z] (eggs/g root)	Egg mass index[y]	Gall index[y]
US-1136	7,622 cd	1.4 c	1.7 c
US-1137	2,701 d	1.2 c	1.4 c
US-1138	2,644 d	1.2 c	1.4 c
Iron Clay	9,032 c	1.1 c	1.4 c
Mississippi Silver	4,862 cd	1.4 c	1.6 c
Coronet	44,102 b	3.7 b	3.9 b
New Era	77,855 a	4.9 a	4.9 a
Pink Eye Purple Hull	96,377 a	4.8 a	4.8 a

[z]Eggs were extracted using 1.0% NaOCl (Hussey and Barker, 1973). Numbers of eggs/g root were $\log^{10}$ (× +1) transformed for analysis of variance to normalize data. Non-transformed data are shown. Means followed by the same letter are not different based on Fisher's protected least significant difference test at $P \leq 0.05$.

[y]Gall and egg mass indices: 1 = 0% to 3% of root system galled or covered with egg masses, 2 = 4% to 25%, 3 = 26% to 50%, 4 = 51% to 79%, and 5 = 80% to 100% of root system galled or covered with egg masses (Thies et al., 1998). Means within a column followed by the same letter are not different based on Fisher's protected least significant difference test at $P \leq 0.05$.

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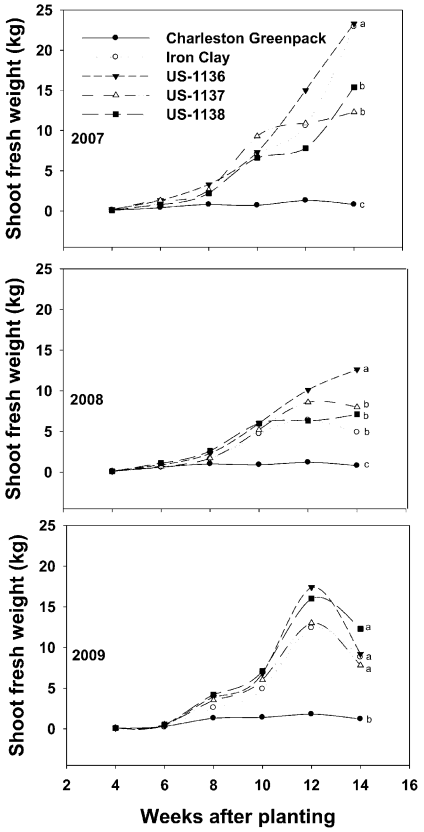

Fig. 1. Shoot fresh weights for cowpea plants grown for 14 weeks without competition from neighboring plants. Cowpea genotypes included in the study were the determinate horticultural (southernpea) cultivar, Charleston Greenpack, the indeterminate forage cultivar, Iron Clay, and the three newly released indeterminate lines, US-1136, US-1137, and US1138. Planting dates were 19 June 2007, 7 July 2008, and 1 July 2009. A significant difference test was used to compare linear regression coefficients (Anonymous, 2013) for the growth curves of the genotypes, and coefficients for genotypes with the same letter at the end of the growth curve are not different at $P \leq 0.05$. $LSD_{0.05}$ for comparing all shoot weights on the plots are 4.0, 1.8, and 3.0 for 2007, 2008, and 2009, respectively. LSD = least significant difference.

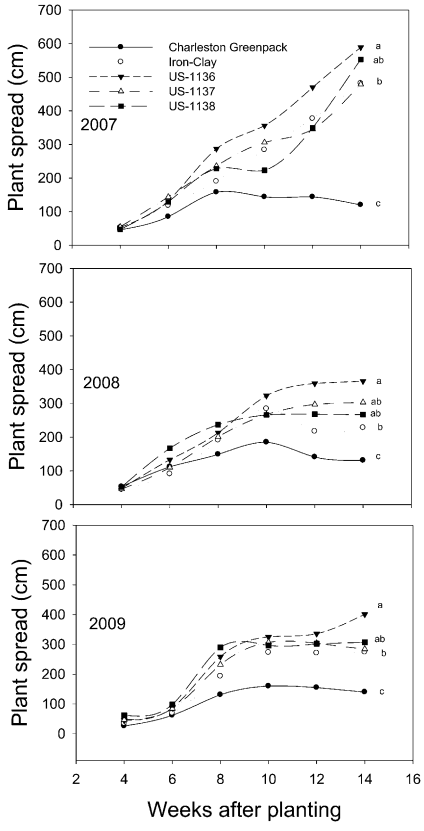

Fig. 2. Plant spread for cowpea plants grown for 14 weeks without competition from neighboring plants. Cowpea genotypes included in the study were the determinate horticultural (southernpea) cultivar, Charleston Greenpack, the indeterminate forage cultivar, Iron Clay, and the three newly released indeterminate lines, US-1136, US-1137, and US1138. Planting dates were 19 June 2007, 7 July 2008, and 1 July 2009. A significant difference test was used to compare linear regression coefficients (Anonymous, 2013) for the growth curves of the genotypes, and coefficients for genotypes with the same letter at the end of the growth curve are not different at $P \leq 0.05$. $LSD_{0.05}$ for comparing all plant spreads on the plots are 81, 43, and 38 for 2007, 2008, and 2009, respectively. LSD = least significant difference.

compact vegetable (southernpea) cultivar, Charleston Greenpack (Fery, 1988) (Fig. 1 and 2). 'Charleston Greenpack' is adapted to standard southernpea cultural practices, which include supplemental nitrogen fertilizer and did not grow well in these experiments without fertilizer. In 2 of 3 years the indeterminate cowpeas grew for 14 weeks after early summer planting. With their extensive growth (Fig. 3), relatively low plant populations are capable of producing a dense canopy and high biomass. Shoot biomass and canopy spread for US-1136 were greater than for 'Iron Clay' in several instances. In an earlier study in which the original landrace populations were evaluated (Harrison et al., 2006), the total shoot dry biomass production by the parent populations of US-1136, US-1137, US-1138, and 'Iron Clay' ranged from 388 to 420 g·m^{-2} at 10 weeks after planting at 10 seeds/m^2. Factorial analysis of variance indicated that over three seasons, environment had a greater effect on biomass production than did genotype. The relatively small variation (less than 10%) in shoot biomass production demonstrates that indeterminate cowpea lines may reach a similar shoot biomass production over time; however, rapid early growth may be beneficial to establish canopy early and suppress weed growth. The nitrogen content of cowpea shoots determined 10 weeks after planting ranged between 2.4% and 3.0% of dry weight, although genotypes were not different (Harrison et al., 2006). Because total biomass production per hectare and nitrogen contents do not vary greatly, the contribution of the US-1136, US-1137, US-1138, and 'Iron Clay' to soil organic matter and nitrogen may be similar despite differences in growth rates.

A typical US-1136 pod is 24 cm long with 14 seeds. Coats of dried seeds have a smooth to wrinkled texture and red color (Fig. 4A). Seed size is large with a weight of 22.1 g per 100 dry seeds, and dry seeds have an ovoid shape. US-1136 plants grown for 12 weeks without competition from neighboring plants reached an average shoot fresh weight of 14.2 kg and plant spread of 3.9 m with profusely twining vines.

A typical US-1137 pod is 23 cm long with 18 seeds. Coats of dried seeds have a smooth texture and a fine buff to brown and black speckling pattern (Fig. 4B). Seed size is medium with a weight of 16.7 g per 100 dry seeds, and dry seeds have an ovoid to rhomboid shape. US-1137 plants grown for 12 weeks without competition from neighboring plants reached an average shoot fresh weight of 10.8 kg and plant spread of 3.2 m with moderately twining vines.

A typical US-1138 pod is 20 cm long with 18 seeds. Coats of dry seeds have a smooth to rough texture and buff to brown color (Fig. 4C). Seed size is small with a weight of 12.6 g per 100 dry seeds, and dry seeds have an ovoid shape. US-1138 plants grown for 12 weeks without competition from neighboring plants reached an average shoot fresh of 10.0 kg and plant spread of 2.7 m with high twining vine production.

Uses

Each of the newly released germplasm lines is recommended for use by those interested in the development of cropping systems that incorporate the use of a warm-season legume cover crop. The high level of nitrogen provided by cowpea cover crop residue is important in organic crop production where the use of synthetic nitrogen fertilizers is prohibited. Additionally, a cowpea cover crop can be left on the soil surface to serve as mulch for subsequent crops. Harrison et al. (2004) studied broccoli production in cowpea cover crop mulch; they reported that broccoli grown in mulched plots exhibited higher yields than broccoli grown on bare soil plots when nitrogen fertilizer was applied at half the recommended rate. They also reported that the mulch persisted through the growing season and suppressed annual weeds. Hutchinson and McGiffen (2000) reported that cowpea mulch suppressed weeds through the growing season and promoted pepper growth and yield in a desert environment. Cover crop mulches positively affect pest management by suppressing weeds and other pests and reducing runoff or groundwater infiltration of pesticides and nutrients. Cowpeas are often used as forage or vegetable crops in subsistence and semisubsistence agriculture in tropical regions. Although the lines US-1136, US-1137, and US-1138 were not evaluated for these purposes, their vigorous growth and high biomass production suggests that they may be suitable for these uses.

Fig. 3. A typical US-1136 plant grown for 12 weeks without competition from neighboring plants. The bar is scaled to ≈1.0 m, and a 188-L drum is in the background.

Fig. 4. Dry seeds of three newly released indeterminate cowpea lines for cover crop use, US-1136 (**A**), US-1137 (**B**), and US-1138 (**C**).

Availability

Breeder's seed of lines US-1136, US-1137, and US-1138 has been released to researchers for evaluation as a cover crop. Small quantities of breeder's seed are available from the senior author for distribution to interested research personnel. US-1136, US-1137, and US-1138 were deposited into the National Plant Germplasm System and assigned PI numbers PI 664531, PI 664532, and PI 664533, respectively. Small quantities of seed are also available from the U.S. Department of Agriculture, Agriculture Research Service, Plant Genetic Resources Conservation Unit, Griffin, GA, for research, development, and commercialization. It is requested that appropriate recognition of the source be given when this germplasm contributes to research or development of a new breeding line or cultivar.

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