Exact plane-symmetric solutions of the spinor-field equation with zero mass parameter and nonlinear term that depends arbitrarily on the $S^2 - P^2$ invariant are derived with consideration of an intrinsic gravitational field. The existence of regular solutions with localized energy density among the solutions obtained is investigated. Equations with power-law and polynomial nonlinearity types are examined in detail. For the power-law nonlinearity, when the nonlinear term entering into the Lagrangian has the form $L_N = A x^n$, where $A$ is the nonlinearity parameter and $n = \text{const}$, it is shown that the initial system of Einstein and spinor-field equations has regular solutions with localized energy density only under the condition $A = -A_2 < 0, n > 1$. In this case, the examined field configuration possesses a negative energy. In the case of polynomial nonlinearity, regular solutions with localized energy density $E_f = \int_0^\infty \sqrt{-g} d^3x$ (upon integration over $y$ and $z$ between finite limits), and an everywhere regular metric that transforms into a two-dimensional space-time metric at spatial infinity are obtained. It is shown that the initial nonlinear spinor-field equations in two-dimensional space-time have no solutions with localized energy density. Thus, it is established that the intrinsic gravitational field plays a regularizing role in the formation of regular localized solutions to the examined nonlinear spinor-field equations.

The Lagrangian of a self-consistent system of spinor and gravitational fields has the form

$$L = \frac{R}{2\kappa} + L_\psi = \frac{R}{2\kappa} + \frac{i}{2} \left( \psi \nabla_{\mu} \psi - \nabla_{\mu} \bar{\psi} \gamma^\mu \psi \right) - m \bar{\psi} \psi + L_N,$$

where $R$ is the scalar curvature, $\kappa$ is the Einstein gravitational constant, and the function $L_N = F(I)$, which depends arbitrarily on the invariant

$$I = (\bar{\psi} \gamma^\mu \psi) \cdot g_{\mu\nu} \cdot g_{\mu\nu}(\bar{\psi} \gamma^\mu \psi) = I_S - I_P = S^2 - P^2, \quad S = \bar{\psi} \psi, \quad P = i(\bar{\psi} \gamma^5 \psi),$$

specifies the nonlinear term of the spinor-field Lagrangian.

The static plane-symmetric metric is chosen in the form

$$dS^2 = e^{2\gamma} dt^2 - e^{2\alpha} dx^2 - e^{2\beta} (dy^2 + dz^2),$$

where the functions $\gamma, \alpha,$ and $\beta$ depend only on the spatial variable $x$ and meet the coordinate condition

$$\alpha = 2\beta + \gamma.$$

From Lagrangian (1) we derive the Einstein and spinor-field equations. The Einstein equations for metric (2) with coordinate condition (3) are written as follows:

$$G^0_0 = e^{-2\alpha} \left( 2\beta'' - 2\gamma' \beta' - \beta'^2 \right) = -\kappa T^0_0,$$

$$G^1_1 = e^{-2\alpha} \left( 2\beta' \gamma' + \beta'^2 \right) = -\kappa T^1_1,$$

$$G^2_2 = e^{-2\alpha} \left( \beta'' + \gamma'' - 2\gamma' \beta' - \beta'^2 \right) = -\kappa T^2_2,$$

$$G^3_3 = G^3_3, \quad T^3_3 = T^2_2.$$

Let us write down the spinor-field equations for functions $\psi$ and $\bar{\psi}$ and also the components of the metric energy-momentum spinor-field tensor

$$i \gamma^\mu \nabla_{\mu} \psi - m \bar{\psi} + 2S \frac{dF}{dI} \psi - 2iP \frac{dF}{dI} \gamma^5 \psi = 0,$$
\[
  \begin{align*}
    i \nabla_\mu \bar{\psi} \gamma^\mu + m \bar{\psi} - 2i \frac{dF}{dt} \bar{\psi} + 2iP \frac{dF}{dt} \bar{\psi} \gamma^5 &= 0, \\
    T_{\mu\nu} &= \frac{i}{4} (\bar{\psi} \gamma_\mu \nabla_\nu \psi + \bar{\psi} \gamma_\nu \nabla_\mu \psi - \nabla_\mu \bar{\psi} \gamma_\nu \psi - \nabla_\nu \bar{\psi} \gamma_\mu \psi) - g_{\mu\nu} L_{sp}.
  \end{align*}
\]

Using spinor-field equations (7) and (8), the Lagrangian of the spinor field \( L_{sp} \) can be represented in the form

\[
  L_{sp} = \frac{1}{2} \bar{\psi} (i \gamma^\mu \nabla_\mu \psi - m \psi) - \frac{1}{2} (i \nabla_\mu \bar{\psi} \gamma_\mu + m \bar{\psi}) \psi + F = -21s \frac{dF}{dt} + 2 If \frac{dF}{dt} + F = -2i \frac{dF}{dt} + F.
\]

With Eq. (10) taken into account, we write down the nonzero components of the energy-momentum spinor-field tensor \( T^\mu_\nu \) in the explicit form

\[
  \begin{align*}
    T^0_0 &= T^2_2 = T^3_3 = -L_{sp} = 2If \frac{dF}{dt} - F, \\
    T^1_1 &= \frac{i}{2} (\bar{\psi} \gamma^1 \nabla_1 \psi - \nabla_1 \bar{\psi} \gamma^1 \psi) + 2If \frac{dF}{dt} - F.
  \end{align*}
\]

In Eqs (7), (8), and (9), \( \nabla_\mu \) denotes the covariant spinor derivative of the form [2]

\[
  \nabla_\mu \psi = \frac{\partial \psi}{\partial x^\mu} - \Gamma_\mu \psi,
\]

where \( \Gamma_\mu (x) \) are matrices of spinor affine connection. The matrices \( \gamma_\mu (x) \) and \( \Gamma_\mu (x) \) are represented in metric (2) as follows:

\[
  \gamma^0 (x) = e^{-\gamma^0}, \quad \gamma^1 (x) = e^{-\alpha \gamma^1}, \quad \gamma^2 (x) = e^{-\beta \gamma^2}, \quad \gamma^3 (x) = e^{-\beta \gamma^3},
\]

\[
  \begin{align*}
    \Gamma_0 &= -\frac{1}{2} \bar{\gamma}_0 \gamma^1 \gamma^1 e^{-2\beta} \gamma^1, \\
    \Gamma_1 &= 0, \\
    \Gamma_2 &= \frac{1}{2} \bar{\gamma}^2 \gamma^1 e^{-\gamma^2 - \beta \gamma^1}, \\
    \Gamma_3 &= \frac{1}{2} \bar{\gamma}^3 \gamma^1 e^{-\gamma^3 - \beta \gamma^1},
  \end{align*}
\]

where \( \gamma^a, a = 0, 1, 2, 3, \) are the Dirac two-dimensional space-time matrices chosen in the form given in [4].

Using Eqs. (15) for \( \Gamma_\mu (x) \), Eq. (7) can be written as follows:

\[
  ie^{-\alpha \gamma^1} \left( \partial \psi + \frac{1}{2} \alpha \right) \psi - m \psi + 2S \frac{dF}{dt} \psi - 2iF \frac{dF}{dt} \gamma^5 \psi = 0.
\]

Let us designate

\[
  2S \frac{dF}{dt} = D(S, P), \quad 2F \frac{dF}{dt} = G(S, P).
\]

From Eq. (16) we obtain the following system of equations for components \( \psi_\rho = V_\rho (x), \rho = 1, 2, 3, 4:

\[
  \begin{align*}
    V'_4 + \frac{1}{2} \alpha V_4 + ie^\alpha (m - D)V_4 + e^\alpha GV_4 &= 0, \\
    V'_3 + \frac{1}{2} \alpha V_3 + ie^\alpha (m - D)V_3 + e^\alpha GV_3 &= 0, \\
    V'_2 + \frac{1}{2} \alpha V_2 - ie^\alpha (m - D)V_2 - e^\alpha GV_2 &= 0, \\
    V'_1 + \frac{1}{2} \alpha V_1 - ie^\alpha (m - D)V_1 - e^\alpha GV_1 &= 0.
  \end{align*}
\]

To solve the system of equations (18), \( D(S, P) \) and \( G(S, P) \) and hence \( S \) and \( P \) must be determined as functions of \( e^\alpha (x) \). From Eqs. (18) we obtain the system of equations for the functions

\[
  \begin{align*}
    S &= \dot{V}_1 V_4 + \dot{V}_2 V_3 - \dot{V}_3 V_2 - \dot{V}_4 V_1, \\
    R &= V_1 \dot{V}_2 + V_2 \dot{V}_1 + V_3 \dot{V}_4 + V_4 \dot{V}_3, \\
    P &= i(V_1 \dot{V}_3 - \dot{V}_1 V_3 + V_2 \dot{V}_4 - \dot{V}_2 V_4).
  \end{align*}
\]