Step-1

We get

$$(y, 1-y) A = (y, 1-y) \begin{bmatrix} 3 & 4 & 1 \\ 2 & 0 & 3 \end{bmatrix}$$

$$= (3y + 2(1-y), 4y, y + 3(1-y))$$

$$= (y+2, 4y, 3-2y)$$

Step-2

Equating $y+2$ and $4y$, we get $y = \dfrac{2}{3}$. For this value of y, we get

$$(y+2, 4y, 3-2y) = \left(\frac{2}{3} + 2, 4\left(\frac{2}{3}\right), 3 - 2\left(\frac{2}{3}\right) \right)$$

$$= \left(\frac{8}{3}, \frac{8}{3}, \frac{5}{3} \right)$$

The maximum value is $\dfrac{8}{3}$.

Step-3

Equating $y+2$ and $3-2y$, we get $y = \dfrac{1}{3}$. For this value of y, we get

$$(y+2, 4y, 3-2y) = \left(\frac{1}{3} + 2, 4\left(\frac{1}{3}\right), 3 - 2\left(\frac{1}{3}\right) \right)$$

$$= \left(\frac{7}{3}, \frac{4}{3}, \frac{7}{3} \right)$$

The maximum value is $\dfrac{7}{3}$.

Step-4

Equating $3-2y$ and $4y$, we get $y = \dfrac{1}{2}$. For this value of y, we get

$$(y+2, 4y, 3-2y) = \left(\frac{1}{2}+2, 4\left(\frac{1}{2}\right), 3-2\left(\frac{1}{2}\right)\right)$$
$$= \left(\frac{5}{2}, 2, 2\right)$$

The maximum value is $\frac{5}{2}$.

Step-5

Out of $\frac{8}{3}$, $\frac{7}{3}$, and $\frac{5}{2}$, the least value is $\frac{7}{3}$. Therefore, the best strategy of Y will have $y=\frac{1}{3}$.

Thus, we have $y^* = \frac{1}{3}$.