Performance of fungicides for controlling soybean rust: updated meta-analysis of control, yield response and profitability (Performance de fungicidas para o controle de ferrugem da soja: metanálise atualizada de eficácia, resposta em produtividade e profitabilidade)

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Recent analyses using 10-year data, up to 2013/2014 season, showed that the efficacy of fungicides evaluated for controlling soybean rust has declined significantly over the years. We gathered additional five-year cooperative trial data (140 trials, starting in 2013/2014 and at seven Brazilian states) for six fungicides, all evaluated using three sequential sprays. The meta-analytic estimates, obtained from fitting a network model to the log of severity and absolute yield, for the means (Tukey's comparison [means followed by the same letter do not differ statistically, $p \leq 0.05$]) of percent control and yield response were: bixafen + prothioconazole + trifloxystrobin (83.9%A, 1024.1 kg/ha A), azoxystrobin + benzovindiflupir (83.5% A, 1,007.5 kg/ha AB), pyraclostrobin + epoxiconazole + fluxapyroxade (79.5% AB, 960.6 kg/ha B), trifloxystrobin + prothioconazole (79.4% B, 895.8 kg/ha C), pyraclostrobin + fluxapyroxade (70.7% C, 814.9 kg/ha D) and azoxystrobin + cyproconazole (48.5%D, 438.2kg/haE). The inclusion of a moderator variable in the model, representing low- (< 45% severity in the non-treated check), mid- (> 45 and < 65%) or high-disease (> 65%) scenario, showed higher response in yield (900 to 1,100 kg/ha) for mid to high-disease for three most effective fungicides. The yield response for these fungicides decreased (700 kg/ha) for the low-disease scenario, but was still higher than the least effective fungicide (300 kg/ha). A decline in percent control was not detected in the five-year period when adding year as moderator variable in the model. The risk (probability) of not-offsetting cost (P_{loss}), calculated using average costs of fungicide + three sequential sprays of the same fungicide and soybean prices (2017/2018 season), was low (P_{loss}<25%) using the best-performing fungicides at moderate- to high-disease scenarios and increased to ~45% for the low-disease scenarios. In conclusion, the triple premixes and one dual premix (azoxystrobin + benzovindiflupir) performed significantly better than the other treatments with regards percent control and yield response. However, the mean yield response of the best, but more expensive, triple mixture fungicides was not enough for an advantageous economic benefit based on the risk analysis. Caution is needed when extrapolating our results to management programs that are not based on sequential sprays of the same fungicide and for conditions of different fungicide costs and soybean price.

Palavras-chave: *Phakopsora pachyrhizi*; severity; chemical control
Apoio: CNPq; Consórcio Antiferrugem