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MEMORANDUM

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(this number was assigned after distribution)

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SUBJECT: MITIGATION PROPOSAL TO REDUCE OCCUPATIONAL EXPOSURES OF
CONCERN TO TRIBUFOS

Overview

The California Department of Pesticide Regulation (DPR) finalized the Exposure Assessment Document (EAD) and the Risk Characterization Document (RCD) for tribufos in 2000 and 2004, respectively (Formoli, 2000; Lewis, 2004). The RCD identified cholinesterase (ChE) inhibition effects and dermal irritation as the most sensitive non-oncogenic oral and dermal toxicological end points and established a margin of exposure (MOE) of 100 as the level of concern. The RCD concluded that the occupational risks for acute effects were not of concern (MOEs of 120-36,000). In contrast, eight out of ten seasonal exposures posed unacceptable risks to workers (MOEs of 23-75) (Lewis, 2004). In 2005, DPR issued a Risk Management Directive (RMD) for tribufos, asking staff to monitor the proposed mitigation being developed by the United States Environmental Protection Agency (U.S. EPA) at the time (increased restricted entry intervals [REIs] and “other measures”) (Gosselin, 2005).

In 2023, U.S. EPA published an updated risk assessment for tribufos (U.S. EPA, 2023) and proposed measures for mitigation of the occupational and spray drift risks. The mitigation measures included reduction in the maximum application rates (0.75 lbs. of active ingredient per acre [AI/a] for aerial and 1.125 lbs. AI/a for ground applications), reduction in the amounts of pesticides handled daily, increase in REI from 7 to 10 days for applications using rates above 0.75 lbs. AI/a, control of droplet size, and buffer zones for residential areas. The revised Federal product labels became effective in September 2023 and were submitted to DPR by the registrants in August 2024.

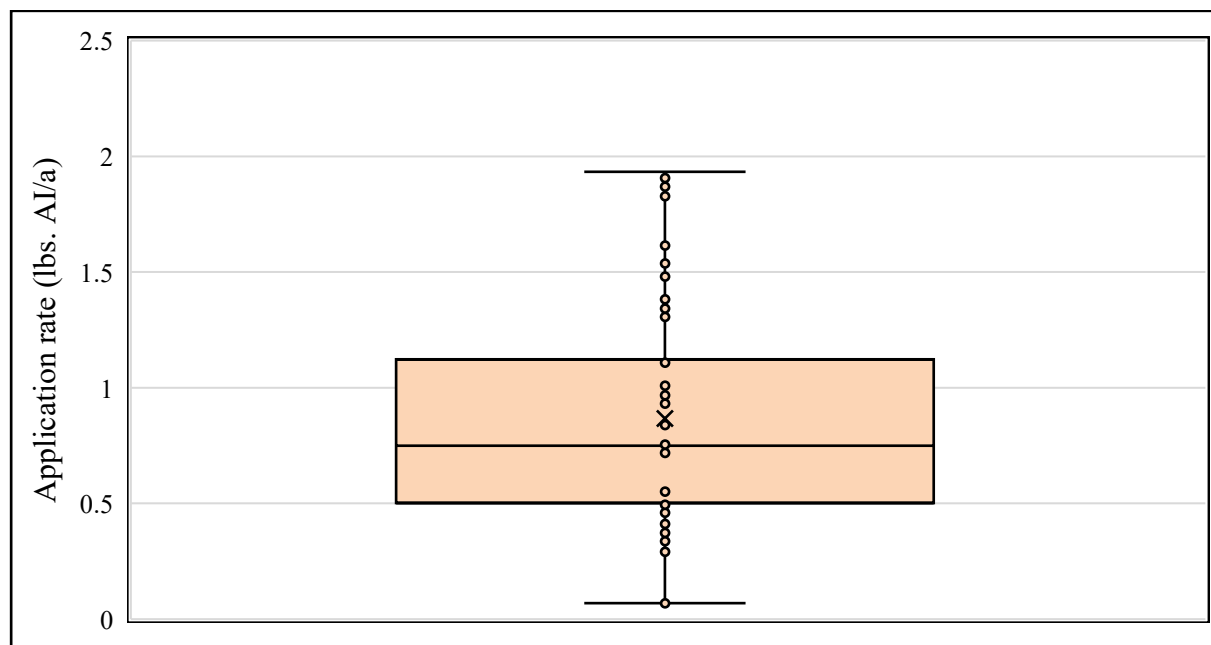
In 2023, DPR updated the estimates for the seasonal occupation MOEs identified as unacceptable in the 2004 RCD, to reflect the 2023 mitigation measures adopted by U.S. EPA, and to adjust for the typical tribufos use in California. The overall seasonal non-cancer occupational risk was mitigated, except for two scenarios: mixing and loading (M/L) in support of ground applications, and irrigator/weeder (Stefanova-Wilbur, 2024).

This memorandum explores the mitigation options for these two scenarios.

Mixer/loaders supporting ground applications (handlers)

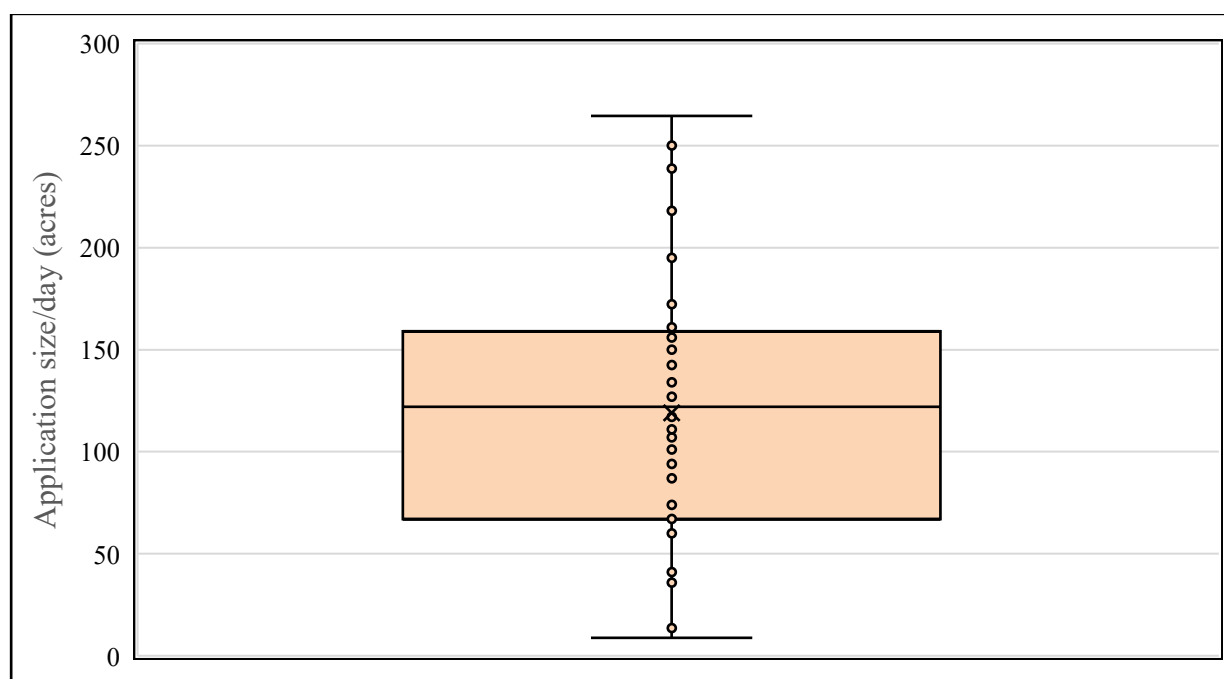
The risk estimate for the M/L (ground) scenario was derived from a 1993 crop- and chemical-specific handler exposure study in which mixer/loaders were monitored supporting the treatment of tribufos to 133 acres of cotton in an 8-hour workday at an application rate of 1.9 lbs. AI/a—the maximum rate allowed in California at the time. The personal protective equipment (PPE) of the workers consisted of aprons over work clothing, nitrile gloves, rubber boots, and goggles. The workers also used a closed M/L system (Formoli, 2000). The exposures under these conditions resulted in a seasonal MOE of 30 (Lewis, 2004). Adjusting the exposure estimate for the mean application rate (0.87 lbs. AI/a, Figure 1) as a representative of the typical use in California resulted in an MOE of 55 (Stefanova-Wilbur, 2024).

Figure 1. Distribution of application rates by ground equipment in California from 2012-2021 (DPR, 2022a, 2022b; DPR, 2023). Mean=0.87 lbs. AI/a (standard deviation [SD]=0.41), 95% upper confidence limit for the mean (UCL 95%)=0.88 lbs. AI/a, n=2498, X signifies the mean.



The size of the experimental fields in the exposure study (Formoli, 2000) is smaller than the 200-acre value U.S. EPA uses as a default field size treated per day for high-acreage field crops (U.S. EPA, 2021; U.S. EPA, 2023), but it is close to the mean cotton acres treated daily with tribufos in California (Figure 2).

Figure 2. Distribution of field size (acres) treated per day with tribufos by businesses using ground equipment in California in 2021 (DPR, 2023). Mean (SD)=119 (64) acres/day, UCL 95%=138 acres/day, n=44, X signifies the mean.



The PPE and engineering controls included in the M/L risk estimates (Formoli, 2000) are compliant with the currently active product labels in California. The label requirements, combined with the California regulations, provide the maximum reasonable worker PPE for handlers under the conditions of the exposure study described in Formoli (2000).

Therefore, further risk mitigation is possible by limiting the amount of active ingredient (AI) the mixer/loaders handle per day *via* reduced application rate and/or daily acreage treated. Table 1 presents a mitigation array using these two exposure parameters.

Table 1. Seasonal MOEs for mixer/loaders supporting ground applications at various application rates and treated acres. MOEs>100 are not of concern (shown in green font and italicized). MOEs<100 present concern for worker health (shown in red font and italicized).

Application rate (lbs. AI/a)	Acres/day										
	30	40	50	60	70	80	90	100	133 ^a	150	200 ^b
0.3	<i>710</i>	<i>533</i>	<i>426</i>	<i>355</i>	<i>304</i>	<i>266</i>	<i>237</i>	<i>213</i>	<i>160</i>	<i>142</i>	<i>107</i>
0.4	<i>533</i>	<i>399</i>	<i>320</i>	<i>266</i>	<i>228</i>	<i>200</i>	<i>178</i>	<i>160</i>	<i>120</i>	<i>107</i>	80
0.5^c	<i>426</i>	<i>320</i>	<i>256</i>	<i>213</i>	<i>183</i>	<i>160</i>	<i>142</i>	<i>128</i>	96	85	64
0.6	<i>355</i>	<i>266</i>	<i>213</i>	<i>178</i>	<i>152</i>	<i>133</i>	<i>118</i>	<i>107</i>	80	71	53
0.75^d	<i>284</i>	<i>213</i>	<i>170</i>	<i>142</i>	<i>122</i>	<i>107</i>	95	85	64	57	43
0.87^e	<i>245</i>	<i>184</i>	<i>147</i>	<i>122</i>	<i>105</i>	92	82	73	55	49	37
1.0	<i>213</i>	<i>160</i>	<i>128</i>	<i>107</i>	91	80	71	64	48	43	32
1.125^f	<i>189</i>	<i>142</i>	<i>114</i>	95	81	71	63	57	43	38	28
1.9^g	<i>112</i>	84	67	56	48	42	37	34	25	22	17

^a Daily acres included in the exposure estimates listed in Formoli (2000).

^b Default field size treated per day for high-acreage field crops (U.S. EPA, 2023).

^c 25th %ile application rate for ground applications in 2012-2021 (Figure 1).

^d 50th %ile application rate for ground applications in 2012-2021 (Figure 1).

^e Mean application rate for ground applications in 2012-2021 (Figure 1).

^f Maximum application rate allowed on product labels *after* U.S. EPA mitigation measures (2023).

^g Maximum application rate allowed on product labels *before* U.S. EPA mitigation measures (2023) and included in the exposure estimates listed in Formoli (2000).

Irrigator/weeder (reentry/fieldworkers)

At the time of the preparation of the EAD (2000) and RCD (2004), the REI for tribufos in California was 7 days in accordance with the permit conditions issued by DPR in 2000. U.S. EPA increased the REI at the federal level from 24 hours to 7 days in 2006 (U.S. EPA, 2006). The most recent mitigation effort of the Agency resulted in the adoption of new federal labels in September 2023, increasing the REI to 10 days for applications at rates above 0.75 lbs. AI/a, and keeping it at 7 days for applications at rates below 0.75 lbs. AI/a.

The worker exposure estimates in the EAD assumed baseline attire typical for fieldworkers (long sleeve shirt/long pants and shoes plus socks), a 7-day REI, and a maximum application rate of 1.9 lbs. AI/a (Formoli, 2000). The resulting seasonal MOE was 23 (Lewis, 2004). Adjusting the exposure estimate for a 10-day REI and a typical application rate (0.87 lbs. AI/a) resulted in an MOE of 80 (Stefanova-Wilbur, 2024).

Therefore, further risk mitigation is possible by extending the REI and/or limiting the application rate. Table 2 presents a mitigation array using these two exposure parameters. The seasonal exposures used for calculating the MOEs in Table 2 were adjusted for changes in the application rate and the REI.

Table 2. Seasonal MOEs for irrigator/weeders at various application rates and REIs.

MOEs>100 are not of concern (shown in **green** font and italicized). MOEs<100 present concern for worker health (shown in **red** font and not italicized).

Application rate (lb AI/a)	REI (days)							
	7 ^{a,b}	10 ^c	11	12	13	14	15	16
0.3	<i>121</i>	<i>231</i>	<i>276</i>	<i>324</i>	<i>372</i>	<i>419</i>	<i>419</i>	<i>501</i>
0.4	90	<i>173</i>	<i>207</i>	<i>243</i>	<i>279</i>	<i>314</i>	<i>314</i>	<i>376</i>
0.5^d	72	<i>139</i>	<i>166</i>	<i>194</i>	<i>223</i>	<i>251</i>	<i>251</i>	<i>301</i>
0.6	60	<i>116</i>	<i>138</i>	<i>162</i>	<i>186</i>	<i>209</i>	<i>209</i>	<i>251</i>
0.75^e	48	92	<i>111</i>	<i>129</i>	<i>149</i>	<i>168</i>	<i>168</i>	<i>200</i>
0.87^f	42	80	95	<i>112</i>	<i>128</i>	<i>144</i>	<i>144</i>	<i>173</i>
1.0	36	69	83	97	<i>112</i>	<i>126</i>	<i>126</i>	<i>150</i>
1.125^g	32	62	74	86	99	<i>112</i>	<i>112</i>	<i>134</i>
1.9^a	19	37	44	51	59	66	66	79

^a REI and maximum application rate allowed on product labels before U.S. EPA mitigation measures. (2023) and included in the exposure estimates listed in Formoli (2000).

^b REI on product labels at application rate<0.75 lbs. AI/a per U.S. EPA's 2023 mitigation measures.

^c REI on product labels at application rate>0.75 lbs. AI/a per U.S. EPA's 2023 mitigation measures.

^d 25th %ile application rate for ground applications in 2012-2021 (Figure 1).

^e 50th %ile application rate for ground applications in 2012-2021 (Figure 1) and maximum application rate for aerial applications per U.S. EPA's 2023 mitigation measures.

^f Mean application rate for ground applications in 2012-2021 (Figure 1).

^g Maximum application rate for ground applications per U.S. EPA's 2023 mitigation measures.

Mitigation Recommendations

DPR finalized the risk assessment for tribufos in 2004 and concluded that most seasonal exposures posed unacceptable risks to workers (Lewis, 2004). DPR's updated seasonal MOEs (Stefanova-Wilbur, 2024), which adjust for the most recent U.S. EPA mitigation measures (2023) and for typical application rates in California, mitigate the overall seasonal non-cancer occupational risk, except for two scenarios: M/L supporting ground applications and irrigator/weeder. Mitigation of these exposures to protective levels is possible by limiting the amount of pesticide handled by the mixer/loaders (lower application rates and/or size of treated fields) and by extending the REI and/or reducing the application rates for reentry workers.

To mitigate these exposures of concern to protective levels (MOEs>100), the Worker Health and Safety Branch (WHS) recommends the following:

- For mixer/loaders supporting ground applications:
Reduce the maximum acres treated per day to 70 acres when the application rate is *below* 0.87 lbs. AI/a

or
Reduce the maximum acres treated per day to 50 acres when the application rate is *above* 0.87 lbs. AI/a (see Table 1).
- For irrigator/weeder exposures:
Increase to a 14-day REI when the application rate is *above* 0.87 lbs. AI/a

or
Follow a 12-day REI when the application rate is *below* 0.87 lbs. AI/a (see Table 2).

Implementation of these measures is possible by either amending product labels in consultation with U.S. EPA or developing a new California regulation via the rulemaking process. Given that there are only three registered products and the limited scope of proposed changes, WHS recommends that mitigation action be conducted via product label amendments.

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