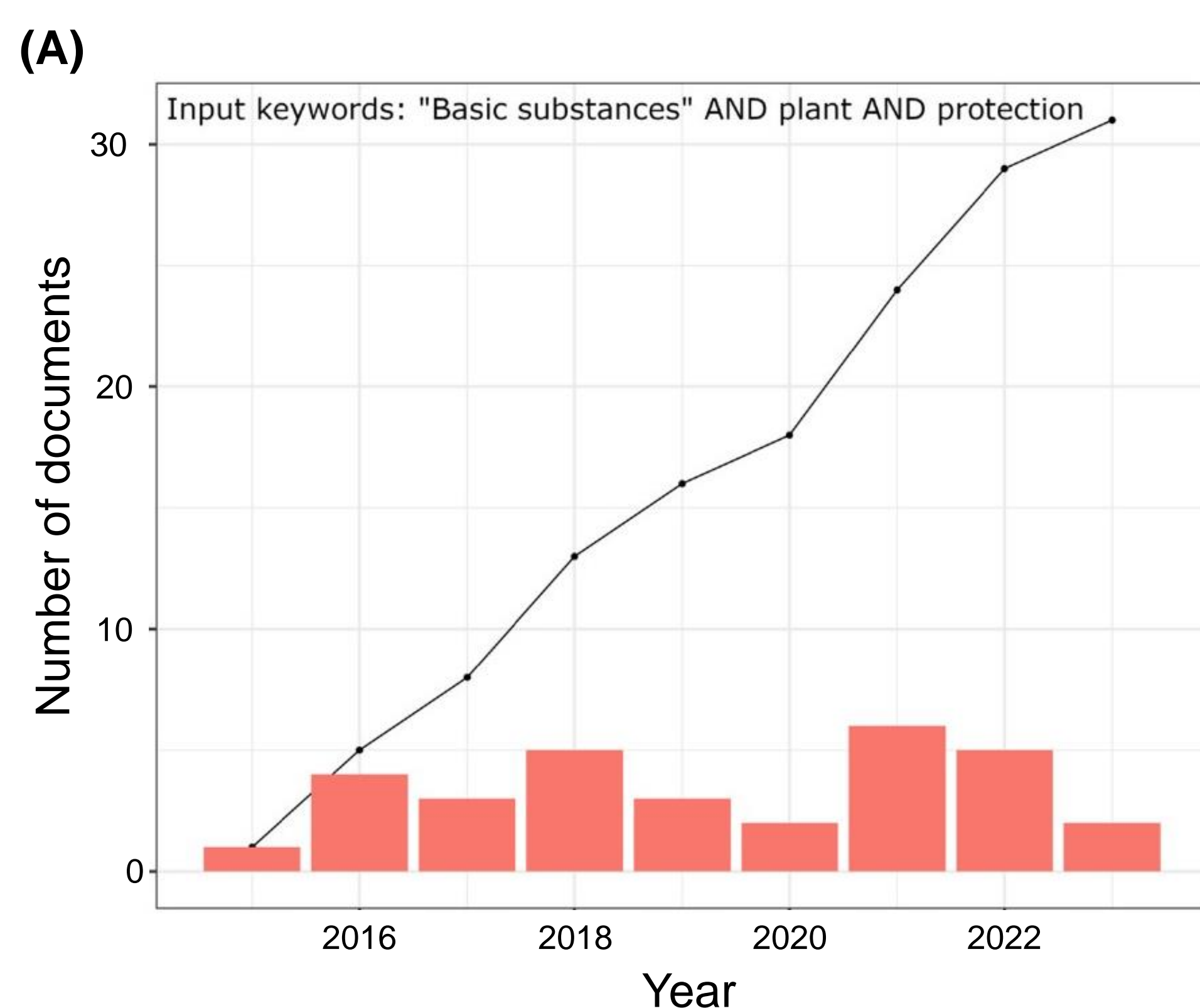


Are Basic Substances a Key to Sustainable Pest and Disease Management in Agriculture? An Open Field Perspective

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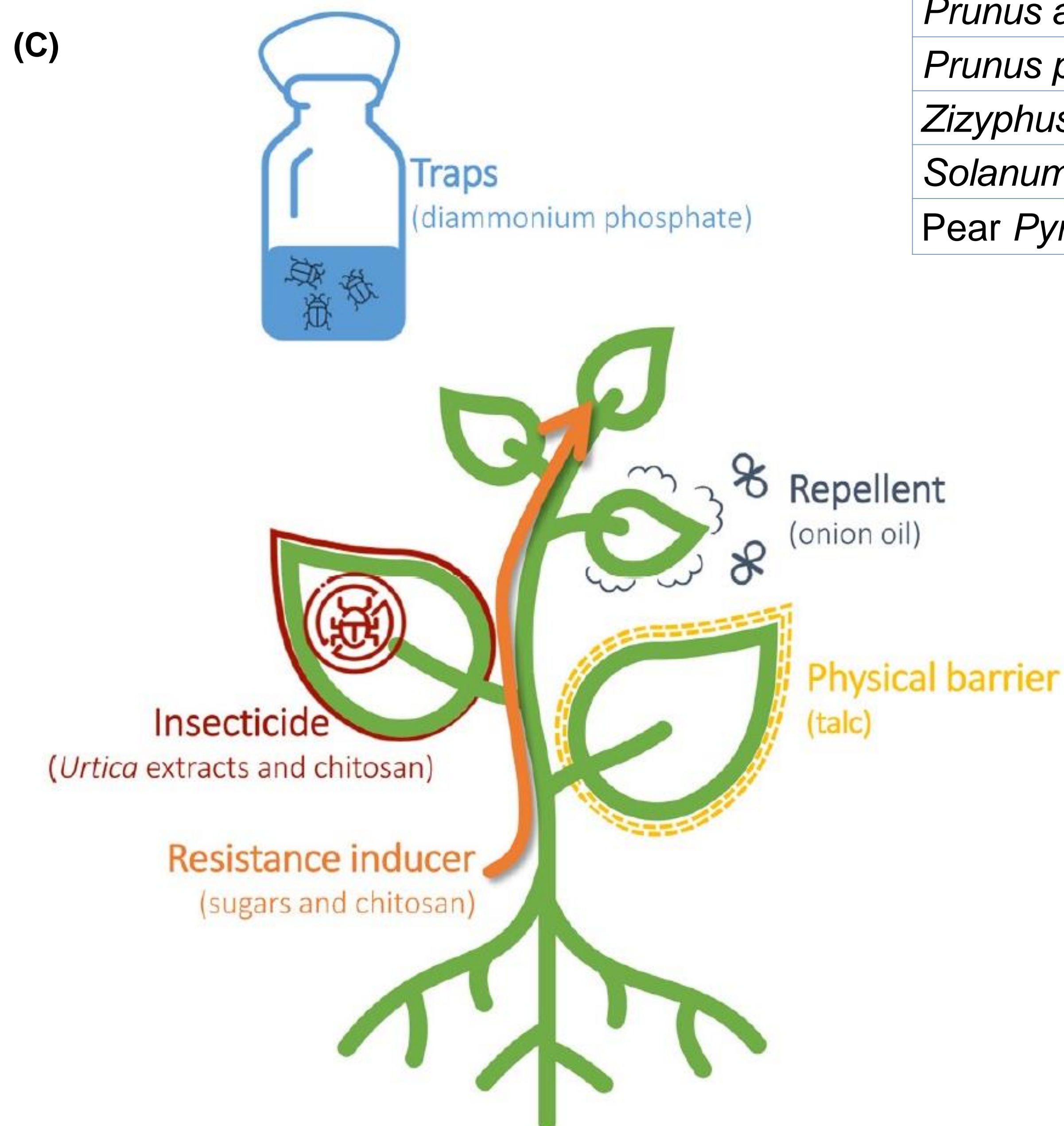
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Pathogens and pests constantly challenge food security and safety worldwide. The use of plant protection products (PPP) to manage them raises concerns related to human health, environment, and economic costs. **Basic substances** (BS) are active, non-toxic compounds that are not predominantly used as PPP but hold potential in crop protection. BS' attention is rising due to their **safety** and cost-effectiveness. However, data on their protection levels in crop protection strategies are lacking. In this review, we critically analyzed the literature concerning the **field application** of known and potential BS for managing **diseases and pests**, investigating their efficacy and potential integration into plant protection programs. Case studies related to grapevine, potato, and fruit protection from pre- and postharvest diseases and pests were considered. In specific cases, BS and chitosan in particular, could **complement** or even **substitute** PPP, either chemicals or biologicals, but their **efficacy** varied greatly according to various factors, including the origin of the substance, the crop, the pathogen or pest, and the timing and method of application. Therefore, a careful evaluation of the field application is needed to promote the successful use of BS in sustainable pest management strategies in specific contexts.



(B)

Crop species	Disease (Pathogen)	Basic Substance
<i>Vitis vinifera</i>	Downy mildew (<i>Plasmopara viticola</i>)	Chitosan
	Botrytis bunch rot (<i>Botrytis cinerea</i>)	Chitosan
<i>Solanum tuberosum</i>	Early blight (<i>Alternaria alternata</i>)	<i>Urtica dioica</i> and <i>Dodonaea viscosa</i> methanolic extracts
	Early blight (<i>A. solani</i>)	Water solutions of <i>Allium cepa</i>
	Late blight (<i>Phytophthora infestans</i>)	Chitosan
<i>Fragaria x ananassa</i> and <i>F. chiloensis</i>	Grey mold (<i>B. cinerea</i>)	Chitosan
<i>Prunus avium</i>	Storage decay	Chitosan
	<i>B. cinerea</i> rot	Sodium bicarbonate salts
<i>Phoenix dactylifera</i>	Storage decay	Chitosan
<i>Actinidia deliciosa</i>	Soft rot (<i>Botryosphaeria dothidea</i> and <i>Phomopsis</i> spp.)	Chitosan
<i>Prunus armeniaca</i>	Decay (<i>A. alternata</i>)	Chitosan
<i>Prunus persica</i>	Decay (<i>A. alternata</i>)	Chitosan
<i>Zizyphus jujuba</i>	Storage decay	Chitosan
<i>Solanum lycopersicum</i>	Storage decay	Chitosan
Pear <i>Pyrus communis</i>	Storage decay	<i>A. cepa</i> extract



(A) Number of scientific publications per year involving basic substances use in plant protection and total accumulated publications (line) over the 2015–2023 period (Scopus database, accessed on March 28 2023).

(B) List of the basic substances which effectively protected the crops described in the present study from specific **diseases**.

(C) Utilization of basic substances in the management of plant pests. Basic substances can be used as insecticides, resistance inducers, physical barriers, repellents, and traps to control and manage plant **pests**.

Chitosan is currently the most used and well-studied BS. Other substances, also show potential, alone alternated or combined with other PPP. BS are not used very often since their field efficacy depends on various factors. Further field experimentation is needed to fully understand BS potential as alternatives to, or partners of, PPP. Field trials also lead to the validation of the most effective application strategies. This review provide promising results on the use of BS in integrated pest management or organic farming strategies for reducing crop protection environmental impact.

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REFERENCE

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