An Integrated Management Approach for Red Palm Weevil *Rhynchophorus Ferrugineus* Oliv. a Key Pest of Date Palm in the Middle East

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حشرة سوسة النخيل الحمراء ، أهم حشرة تصيب النخيل في الشرق الأوسط
أساليب المكافحة المتكاملة لمقاومتها

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الخلاصة: إن نخيل التمر *Phoenix dactylifera* هو أهم مزروع في الشرق الأوسط منذ زمن بعيد. ومنذ أواسط الثمانينات من هذا القرن ظهرت حشرة مرعبة تصيب النخيل وتسبب أضرار جسيمة وهي حشرة سوسة النخيل الحمراء *Rhynchophorus ferrugineus* Oliv. وقد سجلت في عدد من بلدان الخليج وانتشرت بالتدريج لأهم مراكز زراعة النخيل في المنطقة وأصبحت الآن أهم حشرة. إن الظروف المناخية السائدة في الشرق الأوسط وطبيعة هذا المحصول بالإضافة لنقل الفسائل والمنتجات الزراعية ساعدت في إنتشار هذه الحشرة في زمن قصير لايتعدى العقد. إن أكل هذه الحشرة المتخفية داخل جذع النخلة للأنسجة الطرية تؤدي بالضرورة إلى موتها إذا لم تعالج بالوقت المناسب. مع أن العلاج المبكر غير محتمل وذلك لأن اكتشاف الإصابة في وقت مبكر يكون صعباً. وزيادة على ذلك فإن وجود المزارع المهملة والنخيل المجذب (المقطوع الرأس) والاحتفاظ بالرواكيب غير المرغوب فيها . .الخ. لذا فإن هذه المشكلة لها جوانب متعددة ولحصر هذه الجوانب من جميع الزوايا فإننا نقترح لنجاح المكافحة المتكاملة عدة إقتراحات. إستراتيجية المكافحة المتكاملة : المراقبة، وصيد الحشرات بإستخدام المصائد الفرمونية، والكشف عن الإصابة بفحص النخيل، وإزالة المواقع المتوقع تكاثر الحشرات بها، وإزالة المواقع المهملة، والعناية والإهتمام بالمحصول بإجراء العمليات الزراعية اللازمة، والمكافحة الكيميائية، وعلاج النخيل المصاب بالمبيدات الحشرية، وتطبيق إجراءات الحجر الزراعي و التدريب والتعليم.

ABSTRACT: The date palm, *Phoenix dactylifera* L., is the most important fruit crop in the Middle East, cultivated since prehistoric times. Since mid-eighties the dreaded pest of palms viz. the red palm weevil, *Rhynchophorus ferrugineus* Oliv. has been reported to cause serious damage to date palm in certain pockets of the Gulf region. The pest subsequently spread to most of the date growing centres in the region and attained a key pest status. The unique agroclimatic conditions prevailing in the Middle East and the nature of the crop, coupled with transportation of planting material have helped in the rapid development and spread of the pest in a short period of about a decade. Feeding of the soft tissues by this concealed borer often leads to the death of the palm, if timely curative measures are not adopted. However, taking up curative measures in the early stage of attack is often not possible as detection in infestation in the early stage is difficult. Moreover, the presence of neglected date gardens, beheaded palms, retention of unwanted off shoots etc. make the problem intricate. To tackle this problem from various angles and successfully combat the pest, the following Integrated Pest Management (IPM) programme is suggested. The major components of the IPM strategy are surveillance, trapping the weevil using pheromones lures , detection of infestation by examining palms, eliminating hidden breeding sites, clearing abandoned gardens, maintaining crop and field sanitation, preventive chemical treatments, curative chemical control, implementing quarantine measures and training and education.

Date palm, Phoenix dactylifera L., is one of the oldest fruit trees in the Middle East and is deeply rooted in the history of the Arab world. Production of dates is estimated at 3.4 million metric tons with the Middle Eastern and North African countries contributing two thirds of the world production.

A number of insect pests have been reported on date palm. However, none except the red palm weevil, *Rhynchophorus ferrugineus* Oliv. (Coleoptera: Curculionidae), are of major economic importance. Red palm weevil was first described as serious pest of date palm by Madan Mohan Lal (1917) in the Punjab

from India. Buxton (1918) found that this pest caused serious damage to date palm in Mesopotamia (Iraq) and further stated the possibility of its presence in other Arabian countries. However, it was only during the mid eighties that red palm weevil attained a major status on date palm in the Middle Eastern region. It is relevant to point out that this insect was first reported in the Indian Museum Notes in 1891 while, Lefroy (1906) first described it as a pest of coconut in India.

As mentioned, above, red palm weevil after gaining entry into the Middle East has firmly established itself on date palm throughout the region. The agroclimatic conditions prevalent in the region and the unique morphology of the crop, coupled with intensive modern date palm farming, have offered the pest an ideal ecological niche. These factors have contributed to the fast multiplication of red palm weevil and in its becoming a key pest of date palm. Also, the bulk and quick movement of date palm offshoots as planting material has led to its rapid spread in a short span of about a decade throughout the Middle Eastern countries.

Symptoms of Infestation

Red palm weevil is a concealed tissue borer, with all its life stages inside the palm. Also, the symptoms of red weevil attack are mostly hidden making early detection of infestation difficult. However, in date palm damage due to this pest is categorised by the presence of the following symptoms, i) presence of tunnels on the trunk and base of leaf petiole, made by the feeding grubs, ii) oozing out of thick yellow to brown fluid from the tunnels which at times form bubbles, iii) appearance of frass (chewed up plant tissue) in and around the openings of tunnels, which may also form a small mound due to the mixing of the frass and the yellow gummy fluid, iv) the fluid inside the infested tunnel and also the chewed up frass are categorized by a typical fermented odour, v) appearance of a dried offshoot mostly those emerging from in between the leaf bases, vi) production of a gnawing sound by the grubs, vii) presence of cocoon/adults in the leaf axils, viii) fallen empty pupal cases /chewed up frass on the ground around the palm and ix) breaking of the stem or toppling of the crown when the palm is severely infested.

Nature of Damage

Eggs of red palm weevil are laid on date palms, mostly in cracks, crevices and wounds caused on plant parts. Another important site of pest entry into the palm is at the leaf axil, from where offshoots emerge. Splitting of the bark is frequently seen in young growing palms. Often weevils take shelter under the split bark and lay eggs within the newly emerging roots. The female weevil makes a hole on the tissue with its snout and deposits an egg inside. This hole containing the egg is cemented, by the female weevil, protecting the egg from damage (Nirula 1965a). The grubs on hatching feed on the surrounding plant tissue. Feeding due to the grubs leads to the formation of tunnels inside the palm. As the grubs prefer soft plant tissue for feeding, they move towards the interior of the palm leaving chewed up plant fibre (frass) behind. This frass combines with the plant sap to form a thick slimy fermented mass filling the tunnel, which may protrude out through the holes on the stem. Often, cavities are formed inside the palm due to feeding by grubs which subsequently leads to tissue decay. Depending on the number of grubs feeding and generations completed in a palm, the size of the cavity varies. In a severely infested palm this cavity may be filled with chewed up frass, decayed plant tissue and all stages of the pest. Often overlapping generations of the weevil are found in such severely damaged palms. Toppling of the palms in advanced stage of infestation may also occur. However, there are instances where the tissue becomes unsuitable for further development of the insect. At this stage the palm may become free of the pest, with the drying up of the cavity, leaving a weak and unhealthy palm in the field.

Usually palms between the age group of 3 to 15 are preferred by the pest. However, infestation also occurs in young seedlings and old palms. In date palm infestations can occur from the collar region to the crown. However, mostly the lower part of the trunk is infested.

Integrated Pest Management Programme

The above mentioned damage due to red weevil in date palm can be detected by noticing one or more of the symptoms. Infestations when noticed early, can be effectively cured by chemical treatments. Undetected infestations lead to the spread of the weevil to the neighbouring palms and gardens. Huge numbers of offshoots are often transported from garden to garden, within a date growing pocket, from area to area within a country and from country to country in the region, as planting material. This situation leads to the carrying of infested offshoots to pest free areas, helping in its spread and establishment. Further, the existence of certain congenial conditions, like the presence of neglected date palm gardens, beheaded palms, poor maintenance of palms resulting in retention of unwanted offshoots, prevalence of certain agronomic practices (removal/retention of dried petioles), piling up of

uprooted palms etc., also contribute towards the multiplication of the pest. Since, several factors as mentioned above contribute to weevil infestation in date palm, relying on any single method of control to combat this pest is insufficient. Taking into consideration of the above, it is recommended to employ different pest control tactics involving an Integrated Pest Management (IPM) programme for effectively managing red palm weevil on date palm.

Red palm weevil has been successfully managed on coconut in India using an IPM programme (Abraham and Kurian, 1975, and Abraham et al, 1987). The major components of the IPM programme for weevil control on coconut are: surveillance of the pest; maintaining plant and field sanitation; trapping adult weevils; preventive chemical treatment of wounds; treating the crown of bud rot diseased/ *Oryctes* attached palms which attract the weevil, with combination of fungicide and insecticide; filling the leaf axils of young palms with a mixture of insecticide and sand; curative chemical treatment of infested palms; cutting and burning of severely infested palms; discouraging the making of wounds on the stem and cutting of leaves if required, at a distance of one meter away from the leaf base; and educating farmers and agricultural workers on palm weevil management.

Taking into consideration the agroclimatic conditions prevailing in the Middle East, the nature of the crop and habit of the pest, the above programme has been modified, and was first initiated by the Ministry of Agriculture and Water, Kingdom of Saudi Arabia, for palm weevil control on date palm in 1993 (Abozuhairah et al, 1996). Over the last four years this strategy has been refined from time to time and the following IPM programme for palm weevil control on date palm is recommended.

SURVEILLANCE: Detecting the presence of the weevil in a date growing area is imperative. This can be achieved by taking up periodic surveys for detecting infestations, if any, by examining the palms utilising the above listed symptoms. Vast areas can be brought under survey and surveillance, which can be monitored by setting pheromone traps as "monitors" to detect the presence of the weevil. Upon noticing the insect for the first time in a particular area, it should be informed to the concerned authorities, so that necessary measures to control the pest can be taken at the earliest.

TRAPPING THE WEEVIL: Trapping the red weevil using suitable attractants and destroying them is one of the important components of the IPM programme. Hagley (1965), reported the use of a chemical mixture as an attractant for both sexes of *R. palmarum*.

Further, Maharaj (1973) reported the use of metal traps with coconut petioles for red palm weevil control. However, Kurian et al. (1979) proved the effectiveness of coconut logs over metal traps in trapping red palm weevil. Subsequently, Kurian et. al. (1984) found that coconut logs treated with coconut toddy, yeast and acetic acid were significantly superior over other food combinations in trapping red palm weevil. Abraham (1987) found that the addition of BHC into food baited log traps killed the trapped weevils *in situ* without impairing trap captures.

Also, laboratory studies by Abraham (1987) first revealed the presence of pheromones in male *R. ferrugineus*. Hallett et al. (1993) identified the male aggregation pheromone ferruginol (4-methyl-5-nonanol) from *R. Ferrugineus*, while Oehschlager et al. (1993) designed a bucket trap for setting the pheromone in the field. This trap was suitably modified in Saudi Arabia by the Ministry of Agriculture and Water (Anonymous, 1994) to enhance weevil captures. The modified trap is a five litre plastic bucket having four windows 5 x 1.5 cm) cut equidistantly just below the upper rim with jute sackcloth stuck on its exterior to provide better grip for the attracted weevil. The commercially available pheromone lure is hung inside from the lid of the bucket which is filled with 1 kg of date palm stem bits as food, which is necessary to orient the weevil into the trap, along with 11 solution of insecticide (0.1 per cent carbaryl/trichlorphon). The trap is hung on palm stems, 1 to 1.5 m above the ground level in the field. Usually, pheromone traps are serviced for replacing the food and insecticide solution once a week, when the number of weevils captured can also be recorded.

Trapping the weevil using pheromone lures has three distinct objectives, 1) to monitor weevil activity and detect its presence in pest free areas through monitor or survey traps, 2) to mass trap the weevil in hot spots and destroy the floating weevil population and 3) to assess population levels of the pest. Oehlschlaer 1994 recommended setting of monitor traps at a distance of 1 km and mass traps at a distance of 100 m, (4 traps per hectare). It is necessary to maintain a uniform release of the pheromone in the field throughout the trapping programme. Hence, it is essential to constantly monitor the pheromone lure and replace exhausted lures with new ones.

Trapping of weevils by a particular monitor trap consecutively for two to three weeks indicates the presence of infestations in the surrounding area. It is important to locate such infestations as soon as possible to avoid further spread of the pest. However, as monitor traps are set one kilometer apart covering wide stretches of plantation it is often difficult to detect these infestation. To overcome this difficulty a few (4-5) traps can be added 200 m apart around the monitor trap

capturing weevils. These additional traps are called "indicators" which will help the surveyor in reaching close to the infestation. These indicators can be withdrawn after the area is made pest free. However, if a few nearby monitors within a pocket record weevil catches it can be presumed that this area has become an endemic pocket and needs to be mass trapped.

The mass trapping programme of palm weevil using pheromone lures helps to capture and destroy a sizable amount of floating weevils. These captures are female dominated and hence, exert significant pressure on the population buildup of the pest. However, as only a part of the adult weevil population is trapped, pheromone traps will only partially suppress the pest, besides indicating the presence of infested palms in the surrounding gardens, warranting the need for detecting these infestations as soon as possible.

DETECTION OF INFESTATION: Examining palms to locate red weevil infestation forms one of the most important activities of the weevil control programme. Data on weevils caught in pheromone traps can indicate the probable location of the infestation. By limiting weevil control operations in this pocket around the trap, utilization of manpower and facilities can be optimised. However, it should be noted that an infested palm which does not harbour adult weevils will not be known through weevil capture data and also emerging weevils from an infested palm may not always be captured by the trap. Hence, examining palms to locate infestations which may be in different stages of attack is essential, especially in the susceptible age group. Upon examining an infested area, a good number of infestations can be detected through visual symptoms. However, infestations which are completely hidden either by the leaf petiole or the palm matting and those which are at ground level are difficult to detect. Such suspected palms can be examined by using a probe (iron rod or screw driver) which should be thrust into the suspected plant part. On withdrawal of the probe the examiner should smell the adhering fluid, which will emit a characteristic fermented odour, if the palm under scrutiny is infested. At times, infested palms which do not exhibit any external symptoms can be detected by closely listening to the feeding sound produced by the grubs. Hence, depending upon the situation the sense of sight, smell and sound help in detecting infestations.

It is often seen that some gardens remain closed for a long period of time. Such gardens become inaccessible to the surveyor, enabling the pest to go undetected, if present. Infestations in these gardens serve as an inoculum for the spread of the weevil. Efforts may therefore also be made to examine the closed gardens.

Red palm weevil is known to be highly aggregated in its distribution pattern (Anonymous, 1994). Hence, if an endemic pocket of red weevil infestation has developed, intensive examination of palms should be carried out in and around this pocket. Due to the aggregating tendency of the pest, infestations usually occur repeatedly in a garden, especially where a palm is in an advance stage of attack, where adults fly out and lay eggs on neighbouring palms. These palms may exhibit the symptoms of infestation only after a month or so. Also, at times in spite of careful examination some infestations go undetected. Hence, to overcome these situations follow-up examination of such gardens must be repeatedly carried out three to four times at an interval of about two months, ensuring that the garden is made free of the pest.

HIDDEN BREEDING SITES: It is a practice among the farmers to behead unproductive female and excess male palms. The soft cabbage (growing tissue) of the crown is a delicacy and therefore consumed. However, the stump of the beheaded palm is left as such with the tissue remaining intact for a long period. This stump attracts the weevil and serves as a breeding site. Also, often farmers uproot or cut down unwanted palms which are heaped or dumped together. These heaps may also harbour the pest. Such hidden breeding sources form excellent sites for the development and spread of the insect. Identifying and eliminating (cutting and burning) the above breeding sites will contribute towards the overall suppression of the pest.

NEGLECTED OR ABANDONED GARDENS: The intermingling of neglected or abandoned gardens with well managed date palm groves is a common site in the region. These neglected gardens may harbour pest infested palms resulting in the spread of the weevil to the surrounding productive gardens. The palms in the abandoned gardens are usually unapproachable due to the thick weed cover and also the presence of a dense growth of offshoots and many dried leaves. Hence, examination of palms in these neglected gardens and detection of the infestation becomes almost impossible. Even upon finding of an infestation in such palms, taking up subsequent curative measures is very difficult. Therefore, from the weevil management point of view it is important to clear off such neglected palms.

CROP AND FIELD SANITATION: Date palm is characterised by a thick mat cover on the palm stem originating from the petiole and also the production of numerous offshoots by young palms. These conditions offer good protection for the weevil to multiply. Often

the pest hiding in the palm goes unnoticed due to these conditions. Therefore, the periodic removal of old leaves and offshoots will help to maintain a clean palm without hiding sites for the weevil, making pest detection easy. Further, it is seen that plant refuse (cut petioles, stem pieces, etc.) often remain in the garden which may either harbour the pest or become future breeding sites. The removal and burning of such crop refuse is therefore necessary.

Severely infested palms that are beyond recovery may harbour different stages of the weevil. Such palms are to be cut and burned thereby destroying all the insect stages present to prevent further spread.

PREVENTIVE CHEMICAL TREATMENTS: Several wounds are caused on the palm as a result of the periodic removal of leaf petioles and offshoots. These freshly exposed plant tissues attract weevils for egg laying. Hence, the immediate dressing or treatment of such injuries with suitable insecticides is important to prevent pest entry. Abraham (1971) found that in coconut, red palm weevil entry through wounds can be prevented by treating such wounds with BHC or coal tar + BHC. However, taking into consideration the dry weather conditions of the Middle East, tar can be substituted with soil and entry of the pest through wounds on date palm can be prevented by applying a slurry of soil and insecticide (1 kg soil + 10 gm carbaryl 85%), with the help of a brush, immediately after the injury is caused.

Soaking of palms with insecticides is an effective preventive measure. The insecticide once absorbed by the matted fibre on the palm is retained in the leaf axils. The insecticides solution that runs off the trunk forms a thin film and reaches cracks, crevices and cut surfaces, making these sites unsuitable for egg laying. Thus, soaked palms are protected from entry by the weevil. Insecticides, viz. chlorpyriphos, endosulfan, and methidothion at 0.1 percent, are recommended for this purpose. The synthetic pyrethroids, deltamethrin / cypermethrin are preferred during the early fruiting period to reduce the residue hazards. However, soaking is not to be done during the months of fruit maturity. Spraying insecticide on the palm using a high pressure spray machine with a jet lance causes splashing of insecticide on the surrounding area which contaminates vegetable, fruit and fodder crops grown in the palm grove, besides leaving hazardous residues in the irrigation water and soil and exposing the operator himself to the toxic insecticidal drift. In order to minimise these pollution hazards and optimise spray efficiency the use of a special spray lance was suggested by Abraham and Vidyasagar (1992). This soaking lance was fabricated and used by the Ministry of Agriculture and Water, Kingdom of Saudi Arabia which helps to soak (drench) the palms from top to bottom. Soaking the palm with insecticide in this manner can even protect the fruits from getting contaminated, if insecticidal spray are to be taken up during the fruiting period. Apart from preventing pest entry, soaking also gives an additional curative benefit as percolation of the chemical can also destroy different insect stages, if present in the cracks, crevices, leaf axils and cavities on the palm.

Soaking with insecticide also helps in controlling minor pests such as *Oryctes* Spp. and *Jebusaea* Sp.

It has been observed that as a preventive measure farmers in the region dust the entire palm with insecticide powders. This practice has probably been adopted from weevil control in coconut, where Mathen and Kurian (1966) recommended filling leaf axils of young coconut palms with 5 per cent BHC / chlordane along with sand. However, in date palm dusting the whole palm with insecticides has distinct disadvantages, viz. i) polluting the air, soil, water and surrounding intercrops due to drift in windy conditions, ii) health hazard to the farmer and workers by way of direct contact with the insecticide dust on the palm, and iii) making examination of the palm for detection of infestation hazardous.

Once a garden is infested by the weevil it is necessary to make it free of the pest by continued efforts. Hence, each repeat examination of palms, should be followed by repeat soaking of the infested and surrounding gardens, three to four times at an interval of two months is advisable. This is specially important where there was heavy infestation from where adult weevils emerged.

CURATIVE CHEMICAL CONTROL: Once an infested palm is detected it has to be treated immediately. For the curative control of red palm weevil in coconut, Nirula (1956b) recommended the administration of the insecticide pyrethrins - piperonyl butoxide, into the affected part of the stem using a funnel. Mathen and Kurian (1967) and Abraham et al. (1975) recommended the use of carbaryl and trichlorphon, respectively. Also, Abraham (Unpublished) effectively cured infested coconut palms with endosulfan. In date palm administration of insecticide is done after cleaning the affected palm part and removing the insect stages from the cavity as fas as possible. Slanting holes, 5 cm in diameter and 15 cm deep, are made around the affected part using a hollow pointed iron pipe. Then, the insecticide solution is poured into these holes, which kills different stages of the pest if present, in the tissues including the newly hatched larvae. The number of holes to be made may vary according to the infested area on the palm. After a week the palm is to be re-examined and if symptoms still persist, administration of

insecticide may be repeated. It is also necessary to soak these palms to kill unnoticed weevils.

Fumigating infested cavities with aluminum phosphide tablets is one of the curative measures. In date palm the tunnels made by the grubs are plugged by the frass and thick plant sap. This restricts the spread of phosphine gas within the tunnels resulting in only a partial success. However, this method of control can be practiced to destroy the pest present in the palm cavities formed as a result of weevil attack. The success of fumigation depends on preventing of escape of the gas by plugging all outlets on the palm.

QUARANTINE MEASURES: Red palm weevil has attained a major pest status during the mid eighties in certain pockets of the Middle East and surprisingly, within a short span of a decade it spread throughout the Gulf region. The major factor which contributes to be quick spread of the pest is the transport of offshoots as planting material. It is a common sight that truck loads of offshoots even cross international borders. Offshoots of premium varieties are often collected from pest infested gardens and may therefore harbour the pest. Infested offshoots serve as an inoculum for the pest to establish in hitherto uninfested new areas.

The spread and further build up of the pest by way of free movement of planting material can be checked, by imposing strict quarantine laws at national and international levels to ensure that only pest free and certified material is transported. In order to make the planting material free of the pest, it is recommended to dip the bole of the offshoot in 0.1 per cent solution of chlorpyriphos / trichlorphon / endosulphan for 10 minutes. These treated offshoots can be transported after the insecticide dries. The possibility of some insects escaping in spite of the above treatment cannot be ruled out. Hence, upon planting of these treated offshoots in a new garden/area, it is advisable to examine them monthly for a period of six months to detect infestations, if any. Treatment of offshoots and the certification can be taken up by branches of a Central Certification Authority, located in date growing areas.

TRAINING AND EDUCATION: In order to successfully implement the above weevil management strategy, the cooperation of the farmer is essential. At present, palm weevil management in the Middle East is mainly looked after by the government agencies without much involvement of the farmer. For any large scale pest management programme to succeed it is imperative that the farmer cooperates and involves himself at the operational level. This can be achieved by making him aware of the seriousness of the problem and training him on the pest and various IPM skills discussed above. After training the farmers and when the pest incidence is brought down, the responsibility of pest management can be gradually shifted to the farmer in a phased manner, with the government acting as coordinating, advisory and regulatory authority.

Palm weevil has been successfully managed on coconut in India and on date palm in Saudi Arabia. Hence, this intricate problem of red palm weevil on date palm in the Middle East can be tackled by carefully adopting the above Integrated Pest Management strategy.

Acknowledgements

We appreciate the foresight of His Excellency Dr. Abdullah Bin Abdul Aziz Moammer, the Honourable Minister of Agriculture and Water, Ministry of Agriculture and Water (MAW), Kingdom of Saudi Arabia, for visualising the problem of red palm weevil on date palm and formulating a large scale project in Saudi Arabia, implementing an Integrated Pest Management strategy which has become a forerunner for similar attempts elsewhere.

The authors are thankful to His Excellency Mr. Hammad Doige, Honourable Deputy Minister of Agricultural Affairs and Mr. Abdul Aziz Hamdan Al-Judia, Director General, Department of Agriculture and Extension Services, MAW, Kingdom of Saudi Arabia, for granting permission to present this paper at the symposium.

We are also grateful to Mr. Ibrahim Abdul Aziz Al Shuaibi, General Director, Directorate of Agriculture and Water, Al-Hassa, for providing all necessary facilities and help in preparation of this article.

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