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THE INCORPORATION OF THE LOW-VOLUME SPRAYING PRINCIPLE WITH THE USE OF EXOGENOUS PROMOTERS FOR INCREASING THE EFFECTIVITY OF SYSTEMIC PESTICIDES WITH REFERENCE TO THE COTTON PLANT

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Abstract. The present work is a continuation of earlier studies on increasing the effectivity of systemic pesticides with an emphasis on economization and with reference to the cotton plant. It has been found that under local conditions the use of physiological promoters may be successfully incorporated with the low-volume spraying, where increase in the pest control capacities of the pesticide is desired.

The apparent advantages or otherwise related to the ultra low-volume spraying technique will not be discussed here though some literature has been cited in this connection.[6] The striking usefulness of co-ordinating the researches being carried on factors inherent in the process of foliar absorption with those pertaining to the working physics of the low-volume technique has been emphasised earlier.[2] That externally administered sugars under certain conditions can enhance the pest control capacities of pesticides to some measure has been reported earlier.[3] The present work is a continuation of later with an emphasis on further economization on pesticides, physiological promoters and detergents, in relation to local conditions and without compromising the essentials of the technique. In this work, as far as possible, the low-volume principles have been simulated under laboratory conditions incorporating both pesticides and promoters. Initially it was intended to drive more comprehensive data by comparing a better translocating pesticide with a reluctant one, however, only Malathion could be incorporated thus far in these studies. Whereas the broad objectives as well as the need for adoption of relative standards and other conditions of work remain identical with those stated earlier.[2]

Materials and Methods

Cotton seedlings were continuously grown indoors in diffused sunlight with temperatures ranging from 21°C to 22°C in 9×7 cm especially constructed plastic flower pots containing a soil, manure and vermiculite mixture nourished regularly with tap-water enriched with Hoagland's nutrient solution intermittently. A total of 24, fifty-day old seedlings were selected for their homogeneity and size and two leaves from each of the replicates were screened from the rest of the plant body with the help of an adjustment of polythene wrapping as shown in Fig. 1. All the 24 replicates were then allowed to get infested with a fair population of aphids, comprising mostly of *Aphis gossipi*, about 6 hr prior to the start of the experiment, while the density of aphid population per plant was maintained around fifty. However, the aphids were later found to be aggregated in 4–3 colonies broadly covering major portions of the lamina and the petioles of the plants. The total number of replicates were then divided into identical groups A and B each containing twelve individual plants. The two exposed leaves from each plant in group A were moistened with a piece of filter paper dipped in tap-water followed ½ hr later by a spray of undiluted Malathion solution from a given distance using a calibrated Devibliss atomizer resulting in a deposition of approximately 0.5 µl of the pesticide per pair of the exposed leaf surfaces. The treatment of replicates in group B differed from that in group A only in the fact that a few minutes prior to the spraying of undiluted Malathion the exposed leaves were sprayed over with a suger mixture comprising of equal parts of 0.5M sucrose and raffinose added with a trace of acidified (HCl) phenol (approx. 1 µl/50 ml sugar

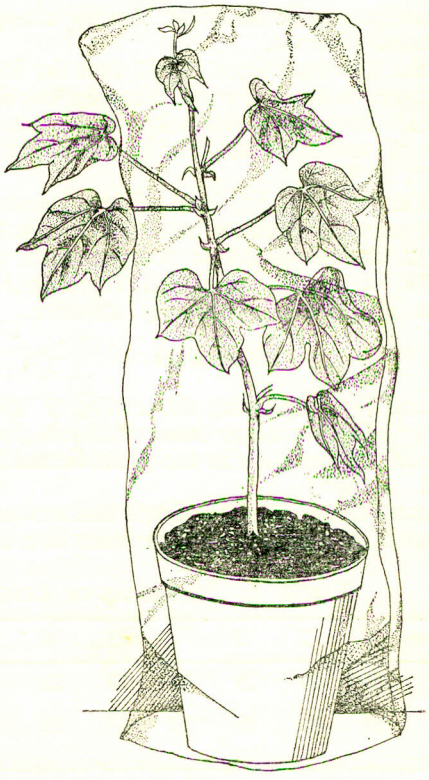

Fig. 1.

mixture solution) respectively, employing another fresh atomizer giving a deposition of approximately of 0.1 µl sugar mixture strength per pair of the exposed leaf surfaces. Following the above treatment the total number of replicates were left under an additional light quota of 400 ft candles from two pair of mercury-vapour tubes for a fixed duration of 8 hr of translocation followed by a 24-hr interval of semidarkness at identical conditions. The temperature at leaf surface during light period varied from 24 to 27°C.

Particulars

(1) Measurements were recorded employing separate Devibliss atomizers in terms of approximate quantities respectively, sprayed per surface area from a measured distance, while arbitrary knock-out value for aphids was fixed by counting as 'dead' those insects as well, which did not actually die but displayed significant agitation at the counting time (2) The data were based on low-volume spraying under laboratory conditions where individual variables were not subject to control. Groups consisting of twelve replicates were incorporated. Analysis of variance and standard error determinations were carried out where necessary using a mini computer (9100B, Hewlett–Packard).*

Observations and Results

At the end of a 24-hr semi-dark period the exposed leaves were swered off, the polythene screening gently removed and the number of aphids dead as well as those adversely effected were recorded for each replicate as shown in Table 1 and projected in Fig. 2 where the so called 'mortality distribution' within the population can be observed directly alongwith the maximas and minimas.

It can be discerned from Fig. 2 that the incorporation of sugar mixture during spraying has furthered the aphid destroying capacity of the pesticide to the tune of approximately 32% variability ranging from 38% to 67%.

The value for '*t*' at 5% level of significance and for eleven degrees of freedom recorded in the Table, is 2.201 and the calculated or computerized value for '*t*' is 2.99. It can be concluded, therefore, that the treatment has been significantly effective.

Discussion

The need for employing the extent of aphid destruction or effection as an index of the degree of distribution of the pesticide in the plant tissues has been discussed earlier.[3]

The experimental results indicate that a considerable movement of pesticide has taken place in a comparatively shorter duration. The somewhat difficult factor of Malathion being a 'Tiefenwirkung' pesticide has been significantly overcome, it seems by the essentials of the technique. The polarity in the phenolic moeities could help closer adherence of particles of the spray aerosol to the leaf surface so that the more hydrophylic pesticidal and sugar complexes are parhaps brought closer to what might be termed as the regularly oriented long pectinaceous channels generally known to exist in the leaf cuticle.[5]

Another factor that would seem to facilitate the entry of such exogenous molecules through the leaf epidermis could well be the low volume state of particles in the aerosol where a kind of kinetic threshold could be visualised as prevailing among the molecules that could contribute in detaching the later from the more aqueous phase outside while providing the necessary energy to cause entry of the same into the lipoidal phase at the same time. The overall entery rates of such exogenous matter, however, would be determined by the factors governing the specific absorption through foliar membranes in genral.[10] As quite a few of these seem to favour higher specific absorption quotients, i.e. optimum leaf surface temperatures, moist condition of the foliar epidermis as well as the vaporous phase of the diffusing molecules, a faster and more effective entery would appear plausable.

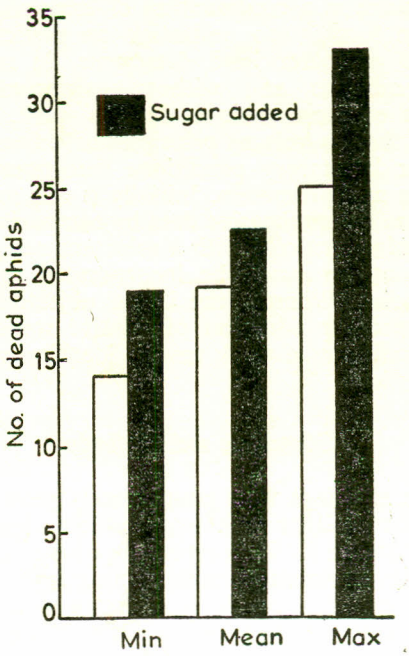

Fig. 2

TABLE 1. MEASURES OF EFFECTIVENESS (figures of 'dead' aphids per replicate).

Composition	1	2	3	4	5	6	7	8	9	10	11	12	Min	Max	Mean	Remarks
Control	15	20	25	17	23	22	17	21	14	18	24	16	14	25	19·3	Increased effectiveness as a result of sugar addition is 32%.
Plus sugar	20	27	24	24	28	19	25	31	33	17	23	26	17	33	25·5	

*Samples of pure Malathion used in this work were obtained from amongst those prepared by Baig A.A. *et al.* at the PCSIR Laboratories, Karachi 39 for W.P.I.D.C.

For the exogenous pesticidal and sugar molecules, perhaps a higher degree of freedom of movement at molecular level also leads to greater number of chance associations or formation of steric-linkages of some manner shared by pesticide and sugar molecules, either during the process of absorption itself, or at some later stage. It has been assumed that with a sugar possessing heavier molecules the chances of such physical contacts would increase hence raffinose has been incorporated alongwith sucrose.

Once the entry through the leaf epidermis has been accomplished movement inside the sieve tubes can be visualised as taking place as the rate of photosynthesis gradually builds up a gradient of the assimilates from the mesophyll into the sieve tube columns alongwhich the external sugars and their associate molecules are diffusing in with fluxes corresponding to a relationship subjective to their respective molecular concentrations.[1]

Cotton seems to be ideally suited for effective radial distribution of the assimilates. Mason and Maskell[9] have already pointed out that in cotton there were distinct movements from sieve tubes into the phloem parenchyma and accordingly phloem structure in cotton seems to posses a more favourable disposition towards the lateral leakage of assimilate or as in the present case, assimilates pregnant with exogenous matter. Whereas this very phenomenon of lateral leakage from sieve tubes could in turn exert an accelerating influence on the linear transport of the assimilates along the length of the phloem strands in accord with the Horwilzian postulates[7] as well as the findings of other workers.[4] Thus with the lateral or radial movement of assimilates bearing an exponential relationship with each other, a comparatively faster and more effective dissemination of the assimilates and pesticidal matter is understandable and is not contradicting the results.

Yet another factor that could further such lateral or radial movement and give it a velocity gradient of its own might well be linked with some activity of galactosidase as a surcrose reviving enzyme[8] in a positive manner. Nevertheless, it is tempting to conceive a linear relationship existing between such enzymatic participation and the comparatively higher rates of radial dissemination of the loaded assimilates.

It is also understandable that the overall distribution of assimilates and their solutes in radial as well as linear fashions would collectively depend upon a number of factors but primarily upon the stage of physiological development of the phloem anatomy as well as the metabolic urgencies of the surrounding tissues, both the later conditions on the other hand would be directly proportional to the metabolic age of the plant itself, with younger replicates, therefore, better results could be anticipated and the same seems to have been substantiated to some degree in the present work.

Although such data provide guidance for a more practical approach as well as a general understanding regards effective foliar uptake and transport of the systemic pesticides for a greater theoretical insight into the precise nature of such process there is need of supplementing the same with an analysis of the solvent extracts at different levels of the plant tissue and it is hoped to persue such objectives in future reports.

Summary

(a) That under local conditions the ULV technique may be favourably incorporated where increase in pesticidal effectivity through physiological promoters, is desired. (b) That through incorporation of such methods not only significant quantitative saving of the pesticide is achieved the saving on promoting sugars can go to the extent of almost 90% and due to this advantage the dependence over the use of natural sugars as suggested in the earlier work[3] has been completely side stepped. (c) The expenditure on the incorporation of the detergents and other inorganic ingredients like boron has been eliminated. The special suitability of cotton plant for such treatment has been demonstrated.

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