Incidence and control of onion fly, *Delia antiqua*, at some irrigation sites in the Upper East Region of Ghana

P. B. TANZUBIL, P. TERBOBRI & E. ANSOBA
Savanna Agricultural Research Institute, Manga Station, Council for Scientific and Industrial Research, P. O. Box 46, Bawku, Ghana

SUMMARY

Studies were conducted between 1994 and 1997 on the incidence, distribution, and control of the onion fly *Delia antiqua* in northern Ghana. Results showed that the insect is prevalent in most of the onion-growing areas and is capable of causing up to 33 per cent crop damage. It was also established that early transplanting (before mid-January) and transplanting of seedlings 6 weeks after emergence reduced *D. antiqua* infestation and crop damage. Neem seed powder and aqueous neem seed extract were as effective as Carbofuran for the control of the onion fly. Economic analysis showed that the neem products were the most cost-effective and had the best returns.

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RÉSUMÉ

TANZUBIL, P. B., TERBOBRI, P. & ANSOBA, E.: *La fréquence et le contrôle de la mouche d'oignon,* Delia antiqua, *à quelques sites d'irrigation dans la région de Upper East du Ghana.* Des études se sont déroulées entre 1994 et 1997 sur la fréquence, la distribution et le contrôle de la mouche d'oignon *Delia antiqua* au nord du Ghana. Les résultats montraient que l'insecte est courant dans la plupart de la zone de la culture d'oignon et capable de causer jusqu' à 33 pour cent de dégâts des cultures. Il a été également établi que le repiquage tôt (avant mi-janvier) et le repiquage de semis 6 semaines après l'apparition réduisaient l'infestation de *D. antiqua* et les dégâts des cultures. La poudre de la graine de margousier et l'extrait de la graine de margousier aqueux étaient aussi efficaces que Carbofuran pour le contrôle de la mouche d'oignon. Les analyses économiques révélaient que les produits de margousier étaient les plus rentables et donnaient les meilleurs résultats.

Introduction

Onion (*Allium cepa* L.) is an important cash crop for farmers in the northern savanna zone of Ghana. The young leaves and fresh bulbs are also eaten raw in salads while the mature bulbs form important ingredients of stews, soups, and gravy. The crop is also reported to possess some medicinal properties (Norman, 1992). Onion is usually cultivated under irrigation between November and April with water from small dams and dugouts. It is continuously cultivated on the same fields annually, and this has resulted in the proliferation of pests and diseases in the main production areas. According to Norman (1992), the yield of onion in northern Ghana varies between 15 and 25 t/ha, but recent studies have shown that yields are up to 30 t/ha (Tanzubil & Yakubu, 1996). Under farmer conditions, however, such yields are rare, owing largely to the ravages of pests and diseases (Tanzubil & Yakubu, 1996). Other factors that contribute to low onion yields are low soil fertility, the use of traditional production methods, and shortage of water during critical periods of crop growth (Tanzubil & Yakubu, 1996).

Of the entomological problems, only thrips, *Thrips tabacci* (Linderman) and the onion fly, *Delia antiqua* (Meig.) are of economic importance (Tanzubil & Yakubu, 1994; Tanzubil & Yakubu, 1996). While farmers control thrips with

insecticide sprays, no control measures have been developed for the onion fly which has, since 1993, been causing substantial losses in yield and income. *Delia* spp. are important pests of onions the world over (Finch, 1989). The adult flies oviposit in soil near the base of onion plants and emerging maggots attack the roots and other underground portions of plants. The most severe damage is caused by the maggots burrowing into the base of onion seedlings, resulting in wilting and death (Bewster, 1994). The maggots also attack developing and mature bulbs leading to rot (Finch, 1989; TDRI, 1986). Reports from Europe and America indicate that *Delia* spp. can cause between 40 and 100 per cent losses in plant stand (Loosjes, 1976; Harris *et al.,* 1981). Although not accurately assessed, preliminary studies by Tanzubil & Yakubu (1994) indicate that losses due to *D. antiqua* in northern Ghana may be of a similar magnitude.

Several measures have been recommended by some workers for control of the onion fly. These include crop rotation and destruction of debris (TDRI, 1986; Finch, 1989), covering seed beds with cloth or plastics (Finch, 1989), and the use of the sterile male technique (Bewster, 1994). In northern Ghana, however, most of these measures may be inapplicable, and appropriate control measures are yet to be developed.

This paper reports on studies conducted to examine the distribution and extent of damage caused by *D. antiqua,* and to evolve measures for reducing its damage to onions.

Materials and methods

Distribution and abundance of D. antiqua

Systematic surveys were conducted to establish the distribution and relative abundance of *D. antiqua* in the major onion-producing areas of northern Ghana. Farmers' fields were visited randomly (using a list maintained by the local dam committee) at each of four dam sites in the Upper East Region (UER) (Bugri, Binduri, Sakpari, and Wiaga) noted to be key production sites for the crop. Four 1-m quadrats were sampled per farm. The total number of plants and number of plants showing signs of wilting and/or death were recorded. From each quadrat, 10 to 20 plants showing symptoms of wilting and/or death were taken to the laboratory and examined for signs and symptoms of pests and diseases. The percentage of plants infested by *D. antiqua* and the number of maggots recovered were recorded. Ten to 15 farms were examined per dam site, depending on the total catchment area under onion cultivation.

Effect of transplanting date on infestation and crop damage

The period of nursing and transplanting onion varies among farmers even at the same site. Planting time is influenced by the location of a plot within the irrigable area, the harvesting date of preceding crops, and availability of labour. An experiment to determine the effect of four transplanting dates on *D. antiqua* infestation of, and damage to onion was conducted on-farm at Bugri and Binduri in the Bawku East District during the dry seasons of 1996 to 1998. Four-week-old seedlings were used for each transplanting date. Normal agronomic practices were followed, and records were kept on infestation levels (dead seedlings with maggots) in each plot. At harvest, all the plants in each plot were examined. Bulb yields and percentage of damaged bulbs per plot were also recorded.

Effect of age of seedlings at transplanting on onion fly infestation and damage

The effect of the age of seedlings at transplanting on the incidence of *D. antiqua* was also investigated. Seedlings raised in sunken beds in the Binduri garden were transplanted into the field at 4, 6, 8, and 10 weeks after emergence. Transplanting was done in the 1st week of January for each experimental year. The percentage of bulbs damaged by onion fly as well as the number of onion maggots were recorded from 1-m^2 quadrats marked out in each plot at transplanting.

Yields were recorded.

Effect of some synthetic insecticides and neem extracts on onion maggot infestation

The use of insecticides is a common practice in vegetable crop production in the UER, and all sorts of active ingredients are used either separately or in mixtures (Tanzubil & Yakubu, 1996). Unfortunately, proven guidelines and protocols such as effective, active ingredients, their dosages, application frequencies, and schedules or safe periods between application and harvest have not been established for the onion-producing areas. It was, therefore, found prudent to screen some locally available materials for their efficacy against the insect.

The insecticides tested were those already being used by farmers while neem seed extracts were prepared, as described by Tanzubil (1991a), from seed collected at the Manga Agricultural Research Station (MARS). Six-week-old onion (*cv.* Bawku Red) seedlings were transplanted onto 5 m × 12 m beds and treatments applied as follows:

1) Carbofuran (5 % granules): 1 kg ai/ha incorporated into the seedbed.
2) Lambda cyhalothrin (Karate 2.5 EC): 1 l/ha as foliar spray.
3) Aqueous neem seed extract (ANSE) (5 % w: v water): as a foliar spray and sprayed to run off.
4) Neem seed powder (200 kg/ha): applied and worked into the seed bed.
5) Control: no insecticide treatment.

Karate and ANSE were sprayed four times (fortnightly from transplanting) during the crop growth period with a CP15 knapsack sprayer fitted with a standard insecticide nozzle. Furadan and neem seed powder were broadcast once at seed bed preparation and worked into the soil. The incidence of onion maggots was monitored as before and bulb yield and quality measured at harvest.

Economic analysis of onion maggot control using insecticides

Yield data were subjected to economic analysis to determine the economic feasibility and profitability of each treatment. Prices of inputs and outputs were collected for the agronomic trials described earlier and from the Bawku central market, respectively. For the analyses of the data, practical budgets constructed for the various control measures were compared. Costs of maggot control were assessed by the costs of chemicals and the costs in picking the neem seed and preparing the various extracts. Other costs such as costs of labour for picking and processing neem seeds into powder and extracts, and costs for applying the treatments were considered. Labour data were calculated per man-day, while labour cost was assessed at 734.00 cedis per man-day (8-h day). Tables 1 and 2 show the data used for the analyses.

TABLE 1

Average Prices of Inputs and Outputs for 1994 and 1995

Item	*Price (¢)*[1]
Onion bulbs	327.40 per kg
Carbofuran granules	4050.00 per kg
Karate	16,750.00 per litre

[1] $ 1 = 2000 cedis

TABLE 2

Labour Requirements For Various Operations

Operation	*Labour (man days)*
Picking of neem seed by hand (200 kg)	8.75
Pounding of neem seed by hand (200 kg)	7.50
Application of neem powder (NSP)	14.13 per ha
Mixing and spraying of ANSE (5 %)	1.47 per ha
Spraying of Karate	0.79 per ha
Application of Carbofuran	14.48 per ha

Results and discussion

Distribution and relative abundance

Infestation of onions by *D. antiqua* was only observed at three of the four locations and the

number of maggots per bulb varied from 2 to 12 with a mean of 3.45, depending on location, bulb size, and plant age. Bigger bulbs and older plants had higher numbers of maggots. Larval infestation was highest at Bugri, followed by Binduri and Sakpari. No infestation was recorded at Wiaga (Table 3). This variation is probably associated with the length of time that fields at each site had been cropped to onions. Onion production at Wiaga started only in 1993 while at Bugri it started more than two decades ago. Such intensification of production in time can, in its wake, increase pest problems and this might well be so here. Tanzubil (1991b) and Tanzubil & Yakubu (1996) similarly observed higher pest incidence after intensive cultivation of vegetable crops under irrigation in Ghana.

Onion maggots caused an average of 32.56 per cent crop damage (measured as percent rotten bulbs) across the four locations. The surveys showed that *D. antiqua* is widely distributed across the onion-growing areas and that its attack can result in substantial losses in yield and bulb quality. Onion fly attack also tended to predispose affected plants to fungal infection. There is, therefore, the need to consider the interactions between insect and pathogen(s) to better manage the problem of bulb rot in onion production.

TABLE 3

Incidence of Onion Fly at Four Dam Sites in the UER of Ghana

Site	*Bulbs/m²*	*% infested*	*Maggots/bulb*
Bugri	431.67	46.25	6.37
Binduri	379.17	41.63	5.24
Sakpari	308.00	42.35	2.21
Wiaga	414.17	0.00	0.00
Mean	383.25	32.56	3.45
LSD	83.14	7.90	0.81

Effect of transplanting date on infestation and crop damage

Early transplanting tended to reduce infestation and damage by onion fly and produced higher yields (Table 4). This could be because seedlings transplanted later encounter higher pest populations built gradually from earlier crops within the same vicinity. Bulb density and yield also tended to decline with late transplanting. Early transplanting is, therefore, advisable and farmers should transplant their seedlings as early as possible but preferably by the middle of January to reduce onion fly damage and thereby maximise yields and profits.

TABLE 4

Effect of Date of Transplanting on Onion Fly Incidence and Yield of Onions in Northern Ghana

Date	*1995*				*1996*			
	L/m²	*TB/m²*	*RB/m²*	*Yield (t/ha)*	*L/m²*	*TB/m²*	*RB/m²*	*Yield (t/ha)*
Mid-Dec	11.17	115.13	15.50	21.13	6.48	110.50	1.45	26.38
Early-Jan	16.33	126.50	16.33	22.22	11.29	95.25	2.90	29.63
End-Jan	16.83	129.13	60.67	20.05	13.44	97.00	17.40	13.13
Mid-Feb	18.83	97.88	50.50	17.69	13.56	87.25	5.86	8.30
Mean	15.79	107.16	35.75	20.27	11.19	97.50	6.90	19.36
LSD (0.05)	6.52	42.14	14.31	2.84	3.86	31.38	3.25	31.75

L/m² = larvae per square metre; TB/m² = total bulbs per square metre; RB/m² = rotten bulbs per square metre

Effect of age of seedlings at transplanting on onion fly infestation and damage

Younger seedlings were significantly more susceptible (P=0.05) to onion fly attack than older ones. Populations of onion fly larvae and number of rotten bulbs per square metre decreased with increasing age of the seedlings at transplanting (Table 5). This was so probably because older seedlings are less attractive for oviposition by females or that tissues are able to resist penetration by maggots. Bulb yields were highest for 4- and 6-week-old seedlings and lowest for 10-week-old seedlings. Considering the data in totality, 6 to 8 weeks after emergence would seem the best age of seedlings for transplanting. They combine good yield with moderately low maggot damage which may lead to higher income for the farmers (Table 5). Transplanting seedlings that are over 8 weeks old is not advisable, considering the significantly lower yields for all 3 years for this treatment. Norman (1992) similarly recommended that onion seedlings be transplanted out on the field at 5 to 8 weeks after sowing, even though this was not linked to pest control.

TABLE 5

Effect of Seedling Age at Transplanting on Onion Fly Incidence and Damage to Onions in Northern Ghana

Age	*1994*				*1995*				*1996*			
(weeks)	*L/m²*	*RB/m²*	*TB/m²*	*Yield (t/ha)*	*L/m²*	*RB/m²*	*TB/m²*	*Yield (t/ha)*	*L/m²*	*RB/m²*	*TB/m²*	*Yield (t/ha)*
4	18.26	23.14	107.25	29.88	6.24	10.22	98.69	16.12	10.50	8.36	142.80	29.88
6	16.58	18.48	127.25	32.78	7.02	12.24	102.31	25.22	13.00	8.36	133.00	35.63
8	7.25	12.01	118.00	26.95	5.48	4.64	61.56	4.53	9.25	10.55	127.80	19.25
10	6.08	5.78	80.75	12.75	0.59	0.00	63.38	3.14	8.00	7.07	86.00	12.75
Mean	12.04	14.85	108.31	25.55	4.83	6.78	81.49	12.25	10.19	8.59	122.40	24.38
LSD	5.84	3.84	13.47	7.37	3.14	6.05	10.50	9.07	4.50	4.02	31.29	16.01

L/m^2 = larvae per square metre; TB/m^2 = total bulbs per square metre; RB/m^2 = rotten bulbs per square metre

Chemical control

Onion treated with ANSE (5 %), NSP (200 kg/ha), and Carbofuran had significantly (P=0.05) lower maggot infestations and bulb damage than the untreated control (Table 6). Lambda cyhalothrin (Karate), the most popular insecticide at the sites, did not significantly reduce onion fly infestation. This could be because Karate, being a synthetic pyrethroid, acts mainly as a contact poison with no systemic activity. Larvae residing within onion bulbs are, thus, unlikely to pick up lethal doses of foliar applications of this

TABLE 6

Effect of Some Insecticidal Materials on Onion Fly Infestation and Yield of Onions

Treatment	*Rotten bulbs/ m²*	*Larvae/ m²*	*Bulb yield (kg/ha)*
Control	14.86*	3.88*	21683
Lambda cyhalothrin	15.26	3.61	24826
Aqueous neem seed extract (ANSE, 5 %)	8.49	3.59	26850
Neem seed powder (NSP, 200 kg/ha)	5.48	3.16	33000
Carbofuran	3.16	2.90	35335
LSD (P=0.05)	1.85	0.42	5200

* Figures are square root transformed means of original values.

insecticide. Carbofuran, on the other hand, is a carbamate with marked systemic action, and the results show that it can be transported away from the point of application to other parts in concentrations high enough to cause larval mortality. Foliar- and soil-applied neem extracts proved effective against onion maggots. Although sprays of ANSE reduced bulb rot, *D. antiqua* larval populations on plants were similar to those in the control plots. This may be attributed to the antifeedant effects of neem extracts on insects (Schmutterer, 1990; Tanzubil, 1991a). Tanzubil (1995) showed that insects may abound in neem-treated fields for some time after treatment, but their ability to damage the crop would be greatly reduced. The results of this study suggest that ANSE applied at 5 per cent concentration is not directly toxic to onion maggots. The significant reduction in larval populations in NSP-treated plots, on the other hand, suggests some direct effects on *D. antiqua* that may lead to direct toxicity, or to force migration away from treated plants. The results also showed that NSP has systemic action and can, thus, be taken up by the plant in lethal quantities even when applied to the soil, as was so here.

The data show that Carbofuran-treated plots had the highest bulb yields. Apart from directly killing onion maggots, this could be partially due also to the known growth-enhancing effects of the insecticide on crop growth. However, the health and environmental hazards associated with the use of Carbofuran make it inappropriate to recommend it for use in onion production. It is important to stress also that bulb yield *per se* may not decide the profitability of onion production. Bulb quality directly affects the price and storability of the harvested product, and is thus of paramount importance in onion production. Although ANSE-treated plots did not outyield control plots significantly, they produced a significantly higher number of healthy bulbs and resulted in higher economic returns (Table 7).

Economics of maggot control

The economic analysis shows that farmers need to control the onion fly, since the benefit: cost ratio for each treatment covers the cost of control by at least 13 times (Table 7). A minimum of ¢960,000 per hectare is gained by controlling the maggot. The highest net profit resulted from the use of Carbofuran followed by ANSE (5 %), but for benefit: cost ratio, the highest resulted from the use of NSP. The application of Karate at the rate of 1 l/ha had the least net benefit and benefit: cost ratio.

The cost of using neem extracts was significantly lower than insecticide application. Overall, the cost was least in spraying the crop

TABLE 7

Economic Evaluation of Various Onion Fly Control Methods

Treatment	*Yield (kg/ha)*	*Gross profit [1] (¢/ha)*	*Maggot control cost (¢/ha)*	*Net benefit [2] (¢/ha)*	*Gain from Control [3]*	*B/C [4]*
Control	21683	7099014	0	7099014	-	-
ANSE (5 %)	26950	8823430	44069	8779361	1680347	38.1
Neem seed powder	33000	10804200	22229	10781901	3682887	165.2
Karate 2.5 EC (1 l/ha)	24826	8128032	69319	8058713	959699	13.8
Carbofuran (1 kg ai/ha)	35335	11568679	91628	11477051	4378037	47.8

[1]Based on a price of ¢327.40/kg; [2]Gross profit - Maggot control cost
[3]Net profit - Net profit from no control; [4]Gain from control/maggot control cost

with ANSE (5 %) while the use of Carbofuran granules produced the highest production costs. Onion is produced during the off season when there is less demand for labour for other farm activities. Since the use of neem extracts does not involve purchased inputs but only labour, this method of control could be a better alternative for the cash-strapped farmer who is mainly the one into onion production. In addition, neem trees are abundant in the area and with the labour available, the seeds could easily be picked and processed into the extract.

Given the high cost of Karate and the fact that it had the least benefis, its use would not be a viable option for onion production and is thus not recommended. Similarly, although Carbofuran granules produced the highest net profits, its inherent toxicity and high persistence render it a dangerous material to recommend for use in onion production. The high costs of insecticides relative to labour in the study area suggests that the use of NSP would be the best choice for the cash-strapped farmer. The use of these simple extracts together with other cultural measures like early transplanting could prove useful in the fight against the onion maggot in Ghana.

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