

Effects of Transplanting Dates and Insecticide Frequency in the Control of *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) on Onion (*Allium cepa* L.) in Sokoto, Nigeria

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Abstract

Two factors, transplanting date and insecticide frequency were combined to evaluate their effects in reducing population of thrips and yield of onion. Transplanting was done at monthly interval from November through March, while spraying was done fortnightly, starting from three weeks after transplanting (WAT) to nine WAT (3, 5, 7 and 9) using knapsack sprayer at 18.67g a.i./ha. Results showed that early transplanting done in November and December had fewer thrips than the subsequent ones. At 7 WAT, late transplanting made in February had up to 191 thrips/plant and < 1 in the early transplants. First spray was effective in reducing thrips by about 76% and second and subsequent sprays were less effective. There was significant difference between treatments ($P < 0.05$) in spray at 4, 6, 7, 9 and 10 WAT and the bulb yield of onion. The yield showed that two sprays produced up to 52.53 t/ha, nearly doubling the control plots with 31.6 t/ha. November transplant produced up to 60 t/ha and December transplant 51.82t/ha in three-insecticide spray. The average weight of bulbs from plots with 2 sprays and control plots were 238 g and 155 g, respectively.

Keywords: Bulb, Fortnightly, Lambda- λ , Transplanting, Spray

1. Introduction

1.1 Importance of onion

The common onion, *Allium cepa* L. is a vegetable crop of commercial importance throughout the world. The crop ranks second in importance after tomato among the vegetables in Nigeria. It is grown mainly for its bulb, which is used almost daily in every home (Amans *et al.*, 2000). The bulb onion is normally harvested at the start of the dormant period (Brice *et al.*, 1997). Onion can be grown under a wide range of climatic conditions, but they do best in a mild climate without excessive rainfall or extreme temperature. They require cool, moist conditions for early growth, followed by warm, drier conditions for maturation, harvest and curing (Purseglove, 1992).

1.2 Insect pests of onion

Onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) is a major pest of *Allium* crops (Lorbeer *et al.*, 2002). Jones and Mann (1963) considered them to be the most severe pests of onions and their allies and attacks by thrips can totally destroy young plants. Jensen *et al.* (2003) considered *T. tabaci* to be the principal onion pest in eastern Oregon and Western Idaho (U.S.A.) where it can cause yield reductions by feeding on the epidermal cells of the plant, thus reducing the photosynthetic ability of the plant. *T. tabaci* reduce total yields by 4 to 27%, depending on the onion variety, but can reduce yields of colossal sized bulbs by 28 to 73% (Jensen *et al.*, 2002). No cultivar is resistant to thrips (mainly *T. tabaci* Lind. and *Frankliniella schultzei* Trybom) in the dry season or to Purple Blotch (*Alternaria porri*) in the wet season (Green, 1973).

1.3 Control of onion thrips

Shelton *et al.* (2003) noted that continued heavy reliance on lambda-cyhalothrin, and most likely other pyrethroids, would be problematic in New York onion fields. Other control options, such as cultural practices,

should be encouraged but there are no thrips resistant onion cultivars or effective biological control measures that can be used on a reliable basis, other than the conservation of existing biological control through the use of minimal insecticide application. Therefore, this study was designed to

- a) assess the effect of varying transplanting dates on thrips populations and onion bulb yield;
- b) evaluate the optimum number of insecticide sprays for effective thrips reduction and
- c) assess the combined effects of transplanting date and insecticide sprays on the incidence of thrips, their control and bulb yield.

2. Materials and Methods

2.1 Experimental site

Experiments were conducted at the Teaching and Research Farm of Usmanu Danfodiyo University, Sokoto situated at Kwalkwalawa, 5 km from the main campus of the University. Sokoto is located on latitude 13° 01' N and longitude 05° 15'E, 300 m above sea level. In 2000/2001 season, exploratory trials were conducted to identify the major insect pests of onion and in 2001/2002 and 2002/2003 seasons the main experiments were laid out in the field using Randomised Complete Block Design (RCBD). A local variety, Ex-Sokoto was raised in the nursery for eight weeks, before they were transplanted out by placing the seedlings into holes made with a sharp pointed stick at nearly the same depth they stood in the nursery. Poultry manure was applied before transplanting at the rate of 10 t/ha. This was followed by application of 300 kg N. P. K. at two weeks after transplanting (WAT) and 97.8 kg/ha of urea (46% N) at 6 WAT. Two factors; date of planting/transplanting and frequency of insecticide sprays were investigated in a factorial arrangement using randomized complete block design (RCBD) replicated three times. Onion plants were transplanted into 2.5 m x 1.5 m plots accommodating 5 rows of 17 plants/row. Spacing of 30 cm between and 15 cm within row was used.

2.2 Planting and Transplanting

The planting and transplanting dates were as follows:

2001/2002 season	2002/2003 season
P ₁ 18/9/2001	17/9/2002; 12/11/2002
P ₂ 16/10/2001; 11/12/2001	15/10/2002; 10/12/2002
P ₃ 13/11/2001; 8/1/2002	12/11/2002; 7/1/2003
P ₄ 11/12/2001; 5/2/2002	10/12/2002; 4/2/2003
P ₅ 8/1/2002; 5/3/2002	7/1/2003; 4/3/2003
P ₆ 5/2/2002; 2/4/2002	

2.3 Application of Treatments and sampling

Insecticide application was the second factor investigated, in addition to the above. Spraying was done fortnightly starting from third week after transplanting using knapsack sprayer at the rate indicated below. Spray frequencies ranged from zero spray, which received no spray at all, to one spray made only once on the 1 spray plots; two sprays were given to plots marked for 2 sprays. Similar applications were made on three and four sprays, respectively. Two plants were selected by systematic sampling from 2nd and 4th rows at weekly intervals from each plot and excised plants were immediately placed in labeled polythene bags and later kept in a deep freezer. The choice of systematic sampling was to avoid sampling one plant twice, because onion plants usually regenerate. It was observed that on the November and December transplants it was difficult to distinguish between excised and un-sampled plants at 8-9 WAT and the only distinguishing feature was corrugation of leaves in the sampled plants.

Spraying was done with lambda-cyhalothrin (karate) 2.5% i.e. at 747ml/ha (18.67g a.i.) commencing from 3 WAT. This gave an equivalent of 40 ml of karate in 20 litres of water. Drift to adjacent plots was controlled by the use of baft cloth screen which had four corners placed at each end of the plot. There was a waiting period of five minutes to allow the chemical to settle down before removing the screen. Yield data were obtained by

harvesting the middle rows. The foliage was first removed with a knife before digging out the bulb with a large hoe.

3. Results

3.1 Changes in Population of Onion Thrips

In Table 1, at 4 WAT there was significant difference between treatments in their interaction as crops transplanted in November, December and January did not experience serious incidence of thrips in 2001/2002 and 2002/2003 seasons. One spray had reduced thrips population from 16 to 3.8 and 32.7 to 10.5 in the 2001/2002 and 2002/2003 seasons, respectively.

Significant differences were found in interactions between treatments at 6 and 7 WAT ($P < 0.01$) (Table 2) in 2001/2002 and at 6WAT in 2002/2003 seasons. Thrips population was found to increase from 169.5 to 456.3 per plant in one spray and have decreased in 0 spray, indicating that there was an upsurge in number of thrips due to new formed leaves requiring spray. The effect of 2 sprays was seen in 2002/2003 season where there was an increase in population of thrips from 26.3 to 190.7/plant (7WAT) after the effect of spray had subsided from 5-6 WAT. Third spray presented in Table 3 indicates that the number of thrips had increased when the effect of spray had ceased, where the number rose from 131.3 to 496.3 in 2001/2002 season in February plant and from 68.5 to 359 in 2002/2003 on January plant. The control plots had 352.8 as against the 3 spray plots with 68.5 in 2002/2003 season. The effects of the insecticide sprays did not appear to last more than 7 days in the suppression of thrips population after they were applied whether in one, two or three sprays. The last or fourth spray was also found to be effective as there are less than 100 thrips /plant in the sprayed plot at 10 WAT in 2002/2003 season as compared to the control plots with 338.3 thrips/plant.

3.2 Yield Data

The yield data on the combined effects of dates of transplanting and insecticide spray frequencies are presented in Tables 5, 6, 7 and 8. In Table 5, there were no significant differences ($P > 0.05$) in the mean number of bulbs/row in the different dates of transplanting and the different number of insecticide sprays. Table 6 shows that the mean wet weight of bulbs/row and mean weight of bulbs decreased with each date of transplanting in all the spray treatments in the two seasons (2001/2002 and 2002/2003), e.g.; in 2002/2003 season, the mean wet weight per row ranged from 0.12 to 3.75 kg and weight of individual bulbs varied from 11.0 to 268 g. Clearly, early plantings/transplantings favoured the production of larger bulbs.

3.3 Curing of Bulbs

The mean cured weights of bulbs are presented in Table 7. The trend is similar to those described above in the Table 6 except that the values in Table 7 were lower than in Table 6 due to the loss of water from the bulbs during the curing period. Cured onion bulb yield in tons/ha in the unsprayed plots ranged from 0.83 in the March 5 transplanting of 2001/2002 season to 31.6 in the December 11 transplanting of the same season, while it ranged from 1.36 tons/ha in the March 4 transplanting of 2002/2003 season to 33.0 in the December and 46.4 in the November transplanting of the same season (Table 8). Clearly, early plantings/transplantings favoured higher yield as the highest yield of 60.4 t/ha was recorded in 3 sprays in November transplant. Generally, yields from plots sprayed with insecticide once were not better than those from the unsprayed plots (Table 6).

4. Discussion

It can be seen from the result that interaction had an effect on the number of thrips on onion (Table 1). The possible reason why the first insecticide spray and transplanting date did not have any effect on thrips numbers was perhaps due to low thrips population experienced in the field at that time, or the proportion of crops having thrips at that particular time. As expected, the effect of insecticide spray did not last more than 8-10 days. The second insecticide spray was surprisingly effective for two weeks in 2001/2002 season and lasted for just a week in 2002/2003 season.

Shelton *et al.* (1998) reported that onion varieties and insecticide application in combination significantly affected thrips damage, although their interaction was not significant. They observed that even frequent application of insecticides was not sufficient to keep thrips damage at acceptable levels and that planting tolerant varieties, was however a reliable way to keep thrips damage at low levels, even without insecticides. Patil *et al.* (1988) observed that the cultivars, which had a relatively wide angle of leaf emergence, had smaller population than those with a smaller angle and Soni and Ellis (1990) stated that resistance was found to be related to a wide angle of divergence of the two innermost leaves and the distance apart of the leaf blade on the sheath column.

Ibrahim and Adesiyun (2009) found that less than 5thrips/plant were recorded on onion in January, but in February the population rose to 60 thrips/plant. Combining two or more methods agreed with Saxena (1975) who recommended a combination of resistant cultivars and releases of predators, where he observed that *Chrysopa spp* suppressed onion thrips population with judicious application of insecticides during peak period of infestations. In this study, two predators found were *Exochomus flavipes* Thunberg (Coleoptera: Coccinellidae) and *Monolepta duplicata* Chujo (Coleoptera: Chrysomelidae). They were found mostly in March in control plots, but not in sufficient number. Workman and Martin (2002) stated that natural enemies observed in the unsprayed and organic treatments included *Ceranisus menes* Walker, *Aeolothrips fasciatum* Linnaeus, *Buhananiella whitei* Reuter, syrphids and entomogenous fungi, *Neozygites pavispora* but none of them increased sufficiently to provide effective control of the pest. There are a number of natural enemies that help in the control of thrips; none of them alone can reduce thrips population to a low, non-economic density. Furthermore, the intensive use of pesticides in this crop limits natural enemy activity (Reuda and Shelton, 2003). Several natural enemies have been introduced to Hawaii in an attempt to help control this pest. However, only the parasite, *C. menes*, had become established (Mau and Kessing, 2000).

Several authors have recommended a combination of at least two factors, resistant variety with minimal chemical application or the above two plus biological control. But in this investigation a local variety planted at different times revealed that early transplanting without chemical application could produce good yield (Table 8). It also indicated that November transplant yielded 46 t/ha, December transplant 33 t/ha, after which there was heavy decline to 11 t/ha. This showed that there was up to 29 % reduction in yield between November and December transplants, and a further delay reduced the yield by 66 % when December and January transplants were compared.

Looking at the control, one and two insecticide sprays in Table 8, it indicate that there is a substantial increase in yield from 31.6 to 52.53 t/ha (40%) in the December transplant in 2001/2002 season, but in 2002/2003 season, both the November and December transplants differed only slightly with the control with only 6% increase in yield in the two insecticide sprays. This is possibly because of either early invasion in the second year or perhaps the crop was relatively new in the area in 2001/2002 season and escaped attack. The highest yield of 60t/ha was in three sprays in 2002/2003 season. The effect of spray alone produced 27t/ha, Ibrahim and Adesiyun, (2007) and effect of planting alone 47.733t/ha, Ibrahim and Adesiyun, (2009). Similarly, on the cured bulb weight, there was a difference of up to 35% between the two insecticide sprays and the control in 2001/2002 season, and 32.3% between control and three sprays in the December transplant.

The control of thrips resulting in increasing onion yield has been reported. In Nigeria, Raheja, (1973) found that thrips damage may cause up to 41 % loss in yield of onion bulbs and Uvah (1984) found increase of up to 32 % in the insecticide treated plots when compared with the control, in Sudan Kisha (1977) stated that light infestations led to yield losses of at least 39 %, while severe thrips attack reduced onion crop yield by 57 %. Jensen *et al.* (2003) observed that the insect can reduce total onion yield from 4-27 %; Reuda and Shelton (2000) indicated that up to 66 % loss might be caused by thrips. Also Mote (1978) observed that in India 50 % of onion crops may be lost as a result of attack by thrips.

5. Conclusion

This study is in line with the global concern for de-emphasis on the use of chemicals; synthetic or otherwise. It showed that planting early is the best way to achieve higher yield of onion of over 40t/ha by transplanting in November and using chemical karate 2.5EC increased the yield to 60.0 t/ha. It was observed that any transplanting done beyond December will produce very low yield due to severe attack of thrips of 87.9 thrips/plant in 0 spray and 127.5 thrips/plant in 1 spray at 7WAT.

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Table 1. Combined effects of date of transplanting and frequency of insecticidal sprays on thrips population at 4 and 5 weeks after transplanting (WAT) in 2001/2002 and 2002/2003 seasons

Date of transplanting	WAT	Mean no. Thrips/plant at 4 and 5 WAT			
		0 spray		1 spray	
		4	5 WAT	4 WAT	5WAT
2001/2002 season					
11/12/01		0.0(0.0)	0.0	0.0(0.0)	0.0
8/1/02		0.0(0.0)	0.0	0.0(0.0)	0.0
5/2/02		16.0(4.7)	99.2	3.8(3.5)	43.0
5/3/02		54.0(25.6)	86.3	12.7(5.8)	53.3
2/4/02		11.3(12.0)	16.3	4.3(3.7)	19.7
P		0.006	ns	0.006	ns
CV (%)		95.5	83.52	95.6	83.52
2002/2003 season					
12/11/02		0.0	0.8	0.0	0.0
10/12/02		0.7	0.3	0.2	0.0
7/1/03		0.0	0.3	0.0	0.3
4/2/03		32.7	97.3	10.5	88.7
4/3/03		24.7	24.0	12.0	19.7
P		ns	ns	ns	Ns
CV (%)		122.2	114.4	122.2	114.4

ns =not significant

values in bracket are the standard deviation(SD) and dividing by 5 ($\sqrt{25}$) gives standard error($\pm$ SE)

Table 2. Combined effects of date of transplanting and frequency of insecticidal sprays on thrips population at 6 and 7 weeks after transplanting (WAT) in 2001/2002 and 2002/2003 seasons

Date of Transplanting	Mean no. Thrips/plant at 6 and 7 WAT					
	0 spray		1 spray		2 sprays	
	6 WAT	7 WAT	6 WAT	7 WAT	6 WAT	7 WAT
2001/2002 season						
11/12/01	0.0(0.0)	0.0(0.0)	0.0(0.0)	0.0(0.0)	0.0(0.0)	1.7(2.4)
8/1/02	5.3(5.0)	11.7(9.0)	2.8(0.5)	17.7(9.3)	2.2(1.1)	16.5(3.12)
5/2/02	148.2(69.4)	128.7(153.0)	169.5(62.5)	456.3(172.5)	105.8(23.2)	195.3(39.8)
5/3/02	9.0(8.7)	11.0(3.6)	17.0(7.5)	19.0(17.5)	20.3(10.9)	3.7(3.2)
2/4/02	0.3(0.5)	0.0(0.0)	3.0(2.6)	0.0(0.0)	6.0(2.1)	0.0(0.0)
P	0.0002	0.0001	0.0002	0.0001	0.0002	0.0001
CV (%)	79.9	96.7	79.9	96.7	79.9	96.7
2002/2003 season						
12/11/02	0.0(0.0)	1.8	0.0(0.0)	0.2	0.5(0.5)	0.0
10/12/02	1.8(2.0)	5.7	0.0(0.0)	0.3	0.0(0.0)	0.5
7/1/03	1.3(1.0)	87.9	2.8(0.2)	127.5	2.2(2.1)	45.0
4/2/03	170.0(27.4)	98.3	232.0(102.0)	95.0	26.3(26.3)	190.7
4/3/03	47.7(51.2)	64.7	77.3(73.2)	29.0	19.0(13.0)	51.0
P	0.0001	ns	0.0001	ns	0.0001	ns
CV (%)	98.7	00.9	98.7	100.9	98.7	100.9

ns =not significant

values in bracket are the standard deviation(SD) and dividing by 5 ($\sqrt{25}$) gives standard error($\pm$ SE)

Table 3. Combined effects of date of transplanting and insecticidal sprays on thrips population at 8 and 9 weeks after transplanting (WAT) in 2001/2002 and 2002/2003 seasons

Date of Transplanting	Mean no. Thrips/plant at 8 and 9 WAT							
	0 spray		1 spray		2 sprays		3 sprays	
	8 WAT	9 WAT	8 WAT	9 WAT	8 WAT	9 WAT	8 WAT	9 WAT
2001/2002 season								
11/12/01	0.0	5.0(0.0)	1.7	3.2(1.2)	0.5	2.0(1.5)	0.0	0.8(1.0)
8/1/02	64.3	210.0((73.8)	78.2	208.2(182.6)	64.3	141.0(110.9)	15.8	126.3(21.3)
5/2/02	224.0	78.0(26.5)	178.3	30.7(13.0)	217.0	336.0(112.5)	131.3	496.3(404.0)
5/3/02	24.7	22.2(6.7)	26.3	21.7(24.1)	34.0	34.8(16.9)	15.8	11.3(3.6)
2/4/02	1.7	-	0.0	-	0.0	-	0.0	-
P	ns	0.006		0.006		0.006		0.006
CV (%)	92.8	109.7	ns	109.7	ns	109.7	ns	109.7
2002/2003 season								
12/11/02	0.2(0.2)	2.0	0.0(0.0)	1.3	0.2(0.2)	2.0	0.0(0.0)	0.8
10/12/02	3.7(4.7)	32.5	2.3(3.2)	25.7	2.0(1.3)	13.7	0.0(0.0)	3.2
7/1/03	352.8(154.5)	608.3	306.2(113.8)	486.0	302.7(190.2)	442.3	68.5(24.5)	359.0
4/2/03	144.3(109.4)	92.0	144.0(7.0)	93.0	218.3(72.5)	90.3	92.3(19.5)	87.3
4/3/03	48.3(70.7)	31.7	21.3(15.0)	6.7	42.0(28.8)	27.7	19.0(22.5)	10.7
P		ns	0.003	ns	0.003	ns		ns
	0.003						0.003	
CV (%)		70.5	84.7	70.5		70.5		70.5
	84.7				84.7		84.7	

ns =not significant

values in bracket are the standard deviation(SD) and dividing by 5 ($\sqrt{25}$) gives standard error($\pm$ SE)

Table 4. Combined effects of date of transplanting and four insecticide sprays on thrips population at 10 and 11 weeks after transplanting (WAT) in 2001/2002 and 2002/2003 seasons

DOT	Mean number of thrips/ plant									
	0 spray		1 spray		2 sprays		3 sprays		4 sprays	
	10 WAT	11 WAT	10 WAT	11 WAT	10 WAT	11 WAT	10 WAT	11 WAT	10 WAT	11 WAT
2001/2002 season										
11/12/01	18.8(14.5)	78.0	24.3(5.5)	75.7	21.7(10.9)	74.8	17.8(8.8)	44.3	7.7(2.7)	26.3
8/1/02	283.0(139.0)	281.0	410.8(147.8)	293.0	269.8(39.3)	408.0	337.5(69.7)	171.3	132.3(46.0)	250.3
5/2/02	12.7(7.2)	4.0	4.7(1.15)	1.3	3.7(3.5)	4.7	58.3(78.2)	2.0	8.7(5.0)	0.3
5/3/02	1.5(2.1)	0.3	8.5(6.9)	0.7	1.5(0.8)	0.0	9.3(3.3)	1.0	3.3(2.5)	0.0
P	0.008	ns	0.008	ns	0.008	ns	0.008	ns	0.008	ns
CV (%)	64.5	159.6	64.5	159.6	64.5	159.6	64.5	159.6	64.5	159.6
2002/2003 season										
12/11/02	20.8(24.1)	61.2	2.5(2.2)	11.7	4.5(3.5)	21.7	9.5(13.8)	7.2	2.8(4.4)	5.2
10/12/02	92.7(56.9)	265.5	37.8(29.8)	245.8	43.7(20.4)	164.0	12.7(7.0)	145.2	8.5(5.6)	108.3
7/1/03	338.3(33.5)	135.3	454.3(15.0)	210.0	254.3(169.5)	116.3	539.0(342.3)	217.0	99.7(8.1)	150.3
4/2/03	88.0(123.4)	43.3	47.3(73.3)	44.7	55.7(80.9)	118.0	69.0(82.2)	51.7	54.3(66.2)	67.3
4/3/03	3.2(2.0)	2.5	2.0(1.0)	1.7	6.2(5.0)	3.2	6.3(6.8)	0.5	4.3(2.0)	7.3
P	0.009	ns	0.009	ns	0.009	ns	0.009	ns	0.009	ns
CV (%)	95.8	67.4	95.8	67.4	95.8	67.4	95.8	67.4	95.8	67.4

DOT= Date of transplanting

ns = not significant

values in bracket are the standard deviation(SD) and taking their square root gives standard error($\pm$ SE)

Table 5. Combined effects of date of transplanting and frequency of insecticidal spray on number of onion bulbs/row of onion in 2001/2002 and 2002/2003 seasons

Date of transplanting	0 spray	1 spray	2 sprays	3 sprays	4 sprays
Mean number of bulbs/row					
2001/2002 season					
11/12/01	15.3	17.7	16.7	15.7	14.3
8/1/02	14.7	13.3	14.7	13.7	17.0
5/2/02	11.7	12.7	12.0	12.0	13.7
5/3/02	5.0	6.7	8.3	6.0	6.7
P	ns	ns	ns	ns	ns
CV (%)	15.95	15.95	15.95	15.95	15.95
2002/2003 season					
12/11/02	14.0	13.0	14.7	16.0	12.0
10/12/02	16.0	17.0	17.0	17.0	16.0
7/1/03	13.3	13.3	13.0	12.7	11.7
4/2/03	14.7	12.8	13.0	13.3	11.3
4/3/03	10.7	11.0	12.7	10.3	10.3
P	ns	ns	ns	ns	ns
CV (%)	16.01	16.01	16.01	16.01	16.01

ns =not significant

Table 6. Combined effects of dates of transplanting and insecticide spray frequencies on wet weight of onion bulbs in 2001/2002 and 2002/2003 seasons

Dates of transplanting	0 spray		1 spray		2 sprays		3 sprays		4 sprays	
	Mean wet weight									
	Kg/row	g/bulb	Kg/row	g/bulb	Kg/row	g/bulb	Kg/row	g/bulb	Kg/row	g/bulb
2001/2002 season										
11/12/01	2.47	161.00	3.39	191.00	4.08	247.00	2.53	160.00	3.07	213.00
	(0.6)	(0.02)	(0.4)	(0.02)	(0.9)	(0.05)	(0.8)	(0.04)	(0.7)	(0.007)
8/1/02	0.80	54.00	0.79	59.00	1.33	77.00	1.61	118.00	1.81	108.00
	(0.2)	(0.007)	(0.2)	(0.01)	(0.2)	(0.01)	(0.07)	(0.006)	(0.3)	(0.02)
5/2/02	0.27	22.00	0.39	30.00	0.50	41.00	0.55	48.00	0.57	42.00
	(0.1)	(0.007)	(0.1)	(0.005)	(0.2)	(0.01)	(0.1)	(0.01)	(0.09)	(0.008)
5/3/02	0.07	15.00	0.12	18.00	0.12	14.00	0.09	14.00	0.11	13.00
	(0.03)	(0.01)	(0.06)	(0.01)	(0.02)	(0.002)	(0.06)	(0.006)	(0.08)	(0.009)
P	0.003	0.001	0.003	0.001	0.003	0.001	0.003	0.001	0.003	0.001
CV (%)	32.0	25.2	32.0	25.2	32.0	25.2	32.0	25.2	32.0	25.2
2002/2003 season										
12/11/02	3.75	268.00	3.39	266.00	3.93	270.00	4.78	297.00	3.17	265.00
10/12/02	2.78	174.00	3.48	205.00	3.14	184.00	4.10	242.00	3.92	245.00
7/1/03	0.95	71.00	0.95	73.00	0.83	64.00	1.17	92.00	0.93	80.00
4/2/03	0.70	47.00	0.45	36.00	0.57	44.00	0.60	44.00	0.38	33.00
4/3/03	0.12	11.00	0.1	8.00	0.16	12.00	0.20	17.00	0.13	12.00
P	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
CV (%)	25.2	19.4	25.2	19.4	25.2	19.4	25.2	19.4	25.2	19.4

ns =not significant

values in bracket are the standard deviation(SD) and dividing by 5 ($\sqrt{25}$) gives standard error($\pm$ SE)

Table 7. Combined effects of dates of transplanting and insecticide spray frequencies on cured weight of onion bulbs in 2001/2002 and 2002/2003 seasons

Dates of transplanting	0 spray		1 spray		2 sprays		3 sprays		4 sprays	
	Mean cured weight									
	Kg/row	g/bulb	Kg/row	g/bulb	Kg/row	g/bulb	Kg/row	g/bulb	Kg/row	g/bulb
	2001/2002 season									
11/12/01	2.37	155.00	3.28	185.00	3.94	238.00	2.24	140.00	2.99	208.00
	(0.64)	(0.02)	(0.38)	(0.01)	(0.8)	(0.05)	(1.0)	(0.05)	(0.72)	(0.007)
8/1/02	0.73	49.00	0.65	47.00	1.05	71.00	1.48	109.00	1.70	101.00
	(0.23)	(0.009)	(0.27)	(0.01)	(0.2)	(0.009)	(0.07)	(0.02)	(0.35)	(0.02)
5/2/02	0.21	18.00	0.32	25.00	0.43	35.00	0.49	42.00	0.49	37.00
	(0.07)	(0.004)	(0.1)	(0.04)	(0.2)	(0.01)	(0.1)	(0.01)	(0.06)	(0.06)
5/3/02	0.06	14.00	0.11	17.00	0.11	14.00	0.08	12.00	0.10	12.00
	(0.04)	(0.01)	(0.06)	(0.01)	(0.02)	(0.001)	(0.05)	(0.006)	(0.08)	(0.09)
P	0.003	0.0006	0.003	0.0006	0.003	0.0006	0.003	0.0006	0.003	0.0006
CV (%)	35.6	27.6	35.6	27.6	35.6	27.6	35.6	27.6	35.6	27.6
2002/2003 season										
12/11/02	3.48	249.00	3.21	252.00	3.71	254.00	4.53	281.00	2.96	247.00
	(0.58)		(0.48)		(0.19)		(0.95)		(1.08)	
10/12/02	2.47	155.00	3.31	195.00	2.99	176.00	3.89	229.00	3.74	234.00
	(0.63)		(0.58)		(0.48)		(0.48)		(0.35)	
7/1/03	0.84	62.00	0.89	68.00	0.76	57.00	1.07	84.00	0.80	68.00
	(0.37)		(0.16)		(0.26)		(0.280)		(0.27)	
4/2/03	0.61	41.00	0.37	30.00	0.49	38.00	0.53	39.00	0.33	30.00
	(0.19)		(0.13)		(0.04)		(0.25)		(0.04)	
4/3/03	0.10	9.00	0.08	7.00	0.13	10.00	0.17	14.00	0.10	10.00
	(0.03)		(0.01)		(0.06)		(0.16)		(0.05)	
P	0.03	ns	0.03	ns	0.03	ns	0.03	ns	0.03	ns
CV (%)	25.8	19.8	25.8	19.8	25.8	19.8	25.8	19.8	25.8	19.8

ns =not significant

values in bracket are the standard deviation(SD) and dividing by 5 ($\sqrt{25}$) gives standard error($\pm$ SE)

Table 8. Combined effects of dates of transplanting and insecticide spray frequencies on the cured bulb yield of onions in tons/ha in 2001/2002 and 2002/2003 seasons

Date of Transplanting	0 spray	1 spray	2 sprays	3 sprays	4 sprays
Mean cured weight of bulbs (tons/ha)					
2001/2002 season					
11/12/01	31.60(8.5)	43.77(5.1)	52.53(11.5)	29.91(13.8)	39.91(9.7)
8/1/02	9.73(3.0)	8.67(3.7)	14.00(2.6)	19.78(1.0)	22.67(4.6)
5/2/02	2.84(1.0)	4.22(1.3)	5.78(3.0)	6.58(1.3)	6.58(0.8)
5/3/02	0.83(0.5)	1.49(0.9)	1.48(0.2)	1.08(0.7)	1.36(1.1)
P	0.003	0.003	0.003	0.003	0.003
CV (%)	35.6	35.6	35.6	35.6	35.6
2002/2003 season					
12/11/02	46.44(7.7)	42.85(6.4)	49.47(2.5)	60.40(12.7)	39.51(14.5)
10/12/02	32.98(8.4)	44.09(7.7)	39.91(6.4)	51.82(6.4)	49.87(4.7)
7/1/03	11.20(4.9)	11.91(2.2)	10.09(3.4)	14.22(3.7)	10.62(3.6)
4/2/03	8.09(2.6)	4.93(1.8)	6.53(0.6)	7.11(3.4)	4.44(0.5)
4/3/03	1.36(0.4)	1.06(0.2)	1.69(0.8)	2.21(2.2)	1.40(0.7)
P	0.03	0.03	0.03	0.03	0.03
CV (%)	25.9	25.9	25.9	25.9	25.9

values in bracket are the standard deviation(SD) and dividing by 5 ($\sqrt{25}$) gives standard error($\pm$ SE)