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RESEARCH ARTICLE

EFFECT OF ORGANIC MANURE ON THE SYMPTOMS DEVELOPMENT OF IRIS YELLOW SPOT VIRUS DISEASE ON ONION (*ALLIUM CEPA L.)*

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ABSTRACT

The effect of organic manure on the symptoms development of Iris Yellow Spot Virus Disease (IYSVD) caused byiris yellow spot virus (IYSV) (of the genus Tospovirus, family Bunyaviridae) in organic onion production was investigated. The randomized complete block design (RCBD), with three replications was used for the experiment. The treatments consisted of six organic manure combinations. These were 0% manure (control), 100% farm yard manure (FYM) equivalent to 4kg/plot, 100% poultry manure (PM) equivalent to 1kg/plot, 50% FYM plus 50% PM, 75% FYM plus 25% PM and 25% FYM plus 75% PM, denoted as T0, T1, T2, T3 ,T4 and T5, respectively. Use of PM in combination with FYM leads to fewer IYSVD incidences than when each manure was used alone. Treatments with no manure (T0) applied leads to high IYSVD incidence 26% and 37% at seven and 10 weeks after transplanting (WAT). The recommended rates of 120Kg N/ha for increased organic onion productivity were identified as; 3Kg FYM mix 0.25Kg PM/plot and 1Kg FYM mix with 0.75 PM/plot. Use of these rates resulted in high bulb and leaf yields of onion 14.58 and 18.75t ha1 respectively. The information generated in this study has greatly improved our understanding of the interactions between the three factors; the host, pathogen and the influence of organic manure, in the IYSVD-pathosystem, which would be highly useful in designing effective disease management strategies for increased organic onion production.

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INTRODUCTION

Onion (*Allium cepa L.*) is one of the leading vegetable crops worldwide, grown for its culinary and medicinal purpose. Onion is part of dietary requirement of poor, since every 100g of green onion contains 90% water, 1% protein, 4% carbohydrate, 2% sucrose, 1% fibers, and 1% ash, 1% vitamins A, B_{one} and C and almost 0% fat (Bello*et al*., 2013; Olam, 2014). One of the advantages of onion is that the leaves can be harvested and sold and can be eaten either 'green' in salads, cook or dry to store for later use (Lannoy, 2001).Onions are biennial, herbaceous plants with tubular leaves and a swollen pithy stem base which function as a drought resistant organ (USAID, 2012). Cultivated types of *Allium cepa* fall into two broad horticultural groups: the Common Onion Group and the Aggregatum Group.

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The former group form large single bulbs, is mostly grown from seeds and constitutes the vast bulk of the economically important cultivars (Smith *et al*., 2011). The latter group has clusters of small bulbs and is usually vegetatively propagated. Onion either green leaves or bulbs are used almost daily in every home and are essential ingredient in Nigerian diet (NIHORT, 2013). The production of onion is of great economic importance to Nigeria and in particular to the people of Kebbi State. The State has suitable condition for the production of the crop (Anon, 2014). There is an increased need for onion production in developing nations to meet the demand for onion as addition to human daily dietary requirements. Onion has several advantages over other vegetables including amaranthus, tomato, and pepper, especially in areas where there are weak market infrastructures, scanty, uncertain rainfall and poor resource base (Smith *et al.,* 2011). Nutritional security is the first priority for farming households in Kebbi State. This security however, is being threatened by Iris yellow spot virus disease (IYSVD). *Iris yellow spot virus* (IYSV) was first reported in

the United States in 1989 and has since been found in Australia, New Zealand and many other countries in Africa including Nigeria (Abad *et al.,* 2003). IYSVD causes lenticular shaped lesions on leaves that can lead to a substantial decline in photosynthesis and reduced onion bulb size (Hogenhout*et al.,* 2008). Symptomatic plants are rendered unsalable, leading to losses in marketable yield (Pappu*et al.,* 2009). The disease symptoms include straw-coloured, dry, tan, spindle or diamond-shaped lesions on the leaves and scapes (stalks) of onion plants (Gent *et al.,* 2006). Some lesions have distinct green centres with yellow or tan boarders; other lesions appear as concentric rings of alternating green and yellow/tan tissue (Pappu *et al.,* 2008). Seed stalks may bend over at the lesion with withering of leaves and flower bearing stalks (straw bleaching) (Pappu *et al.,* 2008). IYSVD expressed typical lesions on the flower stalks and onion bulbs (Abad *et al.*, 2003). Infections at early stages of plant growth cause the greatest damage, often resulting in severe stunting of the entire plant which may lead to death (Munoz *et al.,* 2014). IYSV, movement within infected plants is systemic less readily and sometimes tend to remain localized (Smith *et al.,* 2009). Previous studies found that high C: N ratio of organic manure can enhance the microbial activity and pesticide properties of the soil (Pammel 1989). Organic manure was found to increase the vigour of the plant and reduces the incidence of root rots disease in cotton caused by *phymatotrichumomnivorum* (Pammel 1989). Also application of organic manure to the soil have been shown to prevent spores of *cochliobolus sativus* which causes common root rot of most cereal crops during germination (Gamliel *et al.,* 2012). However, whether or not organic manures have effect on IYSVD incidence in organic onion production have not been studied. Also the amount of organic manure required to lower the IYSVD incidence in onion production is not known. Therefore, this study was carried out to identify the recommended rate in Kilogram (Kg) of organic manure which gives the low IYSVD incidence and high yields in organic onion production. Identifying these rates will be of great assistance to onion growers, researchers and other scientists. The findings from this study can also be used for the control and management of IYSVD, for increased onion production.

MATERIALS AND METHODS

The research was conducted in Fadama Teaching and Research Farm of the Kebbi State University of science and technology, Aliero, located at Jega (Latitude 12^{o} 11$^{'}$ N; Longitude 4^{0} 16$^{'}$ E) during the 2013/2014 dry season, in the Sudan savannah agro-ecological zone of Nigeria. The area is semi-arid, characterized by erratic rainfall that last for about four months (May - August) and long dry period of about seven months (September - April). The average rainfall of the area is about 550 – 650 mm per annum. The relative humidity ranges from 21 – 47 % and 51 – 79 % during the dry and rainy seasons respectively. The temperature averages between 27 – 41^{o} C during dry season and 24 – 30^{o} C during rainy season (NNN, 2012). The soil type and fertility vary from place to place, ranging from sandy loam to clay loam.

Treatments and Experimental Design: treatments were 0% manure (control), 100% farm yard manure (FYM) equivalent to 4kg/plot nitrogen (N), 100% poultry manure (PM) equivalent to 1kg/plot N, 50% FYM + 50% PM (2kg FYM + 0.5kg PM), 75% FYM + 25% PM (3kg of FYM + 0.25kg of PM), 25% FYM + 75% PM (1kg FYM + 0.75kg PM), designated as T_0, T_1, T_2, T_3 ,T_4 and T_5, respectively. The treatments were laid out in Randomized Complete Block Design (RCBD) replicated three times. A total l and areas of 22m x 18m (396 m^2) which is made into 18plots of 4.8m x 3m each was used for planting. The soil samples of the area was collected and evaluated for physical and chemical properties before planting.

Sources of onion seeds

The diseased and healthy onion seeds used in this study were obtained from diseased and healthy onion plants, from the farmer's field in Aliero Local Government Area of Kebbi State.

Cultural practices

The nursery was prepared by ploughing using hoe. The FYM manure was applied evenly on the prepared nursery and then watered. The nursery was watered for 4-5 days to stimulate the release of nutrients from the manure applied. The onion seeds were drilled 20 cm apart. The plots were irrigated daily using watering can. Weeds were frequently removed as they emerge in the nursery by hand pulling. The seedlings were transplanted when they are 15 – 20 cm i.e. 30-35 days of sowing. The intra and inter-row spacing were 10 and 20cm respectively. The irrigation of seedlings was done by surface irrigation method, where the water was drawn from the tube well using water pump and convey to the irrigation channels and distributed to the sub plots. The process was carried out at 3days interval. Weeding was carried out using hoe, after the weeds emerged. They were packed by hand and taken out of the plots after hoeing; this is to prevent their re-establishment after removal.

IYSVD incidence and symptom severity

Number of plants showing disease symptoms were recorded at 10 weeks after transplanting (WAT), for identifying the disease incidence. A total of 96 onion plants were examined for the effect of IYSVD infection during their establishment from symptomless onion plants to the time when plants start showing symptoms. The effect of virus on onion growing leaves, disease symptom severity on the leaves of onion plants were recorded. Leaf symptom severity was scored on 3-month old plants using a five point scale where 1 = no visible IYSVD symptoms, 2 = mild foliar symptoms on some leaves, 3 = pronounced foliar symptoms but no die-back, 4 = pronounced foliar symptoms which might include slight die-back of terminal branches, and 5 = severe foliar symptoms and plant die-back as described in Mohammed *et al*. (2012). Plants grown from healthy plots were scored as control.

Yield Parameters

Plant height was measure from both asymptomatic and symptomatic plants at seven and 10 WAT. The process involved measuring the seedlings using meter rule from the base to the aerial point of the plant to the tip. Bulb diameter

was determined using a veneer caliper from five (5) randomly selected bulbs from each plot after harvest and recorded in (cm).Bulb weight was recorded by taking the weight of ten (10) sampled bulbs from each plot and divided by the total number to get the average bulb weight at harvest. Bulb yield per plot was determined at harvest. It involves weighing the onions bulbs harvested from each plot using weighing balance. This was then calculated to give tons per hectare.

Statistical Analysis

Data collected from various experiments were subjected to analysis of variance (ANOVA) and means are separated using Duncan`s Multiple Range Test (DMRT).

RESULTS

Severe leaf feathering and uniform clearing symptoms were observed on onion. Initial symptoms of this type appeared as faint green spots (Figure 1, black arrow), which later turned into yellow and eventually became necrotic. The spots were distributed throughout the leaf. This was followed by the development of feathery yellowing of all the leaves. The yellowing of leaves is mostly even, spreading throughout the affected leaf which later develops into clear dried and finally dieback (Figure 1, red arrow).

Figure 1. Onion leaves showing symptoms of IYSVD

These are similar to the classical IYSVD symptoms commonly described in the literatures. The rate of organic manure, types and combinations had significant effect on the symptom development of IYSVD on onion (table 1).

Table 1. IYSVD incidence and mean symptom severity score

Treatment	7WAT (%)	10WAT (%)	Mean severity
T_0	26.0	37	4.0
T_1	15.0	18.0	3.0
T_2	6.0	13.0	3.0
T_3	2.0	3.0	2.0
T_4	2.0	3.0	2.0
T_5	2.0	2.0	2.0

IYSVD incidences were significantly higher in T_0 (26%), T_1 (15%) and T_2 (6%) at seven WAT compared to T_5 (2%), T_4 (3%) and T_3 (3%) at 10 WAT. Mean symptom severity score was higher in T_0 (4) than in the treatments with organic manure applications. (Figure 2, table 1). Similarly, organic manure influenced plant height (Table 2). The tallest plants were recorded in T_5 (33cm) followed by T_4, T_3, T_2, and T_1 (33, 30, 30, and 27cm) at 10 WAT respectively. While in contrast the shortest plants were recorded in T_0 (16cm). Number of leaves of onion plants infected by IYSV were higher in treatment without organic manure compared to other treatments with organic manure applications (Table 2).

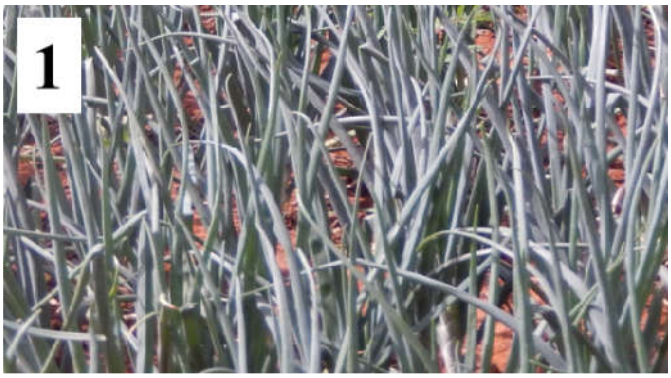

Figure 2. Symptom severity scale 1-5

Highest leave yields were recorded in T_5 (14 leaves) and T_4 (13 leaves) compared to fewer leaves yield harvested from T_0 (8leaves, table 2). Onion bulbs weight harvested from T_5 (34g) was not significantly different from T_4 (33.8g) (Table 3). The highest bulb weights (51.6g) were obtained from T_3, which were significantly different from T_2 (26.1g) at 10 WAT.

prevent spores of *cochliobolus sativus* which causes common root rot of most cereal crops during germination. Huber (1980) observed that root-gall nematode damage on bean decreased with increased ammonium supplied to the plant. Amongst the treatments, the greatest mean severity score was observed on T_0 (score 4.0), followed by T_1 and T_2 (3.0) while T_3, T_4 and T_5 have the lowest mean severity score (2.0) (Table 2). The leaf symptom severity score for each treatment varied (Figure 6). When a multiple comparison using analysis of variance (ANOVA) was used for analysis, significant differences among treatments were observed for the severity of IYSVD symptoms on leaves ($P < 0.001$), indicating that IYSVD severity on onion was affected by the rate and type of manures used during onion cultivation. Our results revealed that pure poultry manure or in combination with farm yard manure at ratio of 25%FYM: 75%PM gives the lowest IYSVD incidence and high onion yields. Based on this experiment it is recommended that poultry manure should be applied to onion in combination with farm yard manure for vigorous onion plant and a higher bulb yield with less IYSVD incidence.

Table 2. Plant height of IYSV infected onion and number of leaves counted

Treatments	Height 7WAT cm	Height 10WAT cm	Number of leaves 7WAT	Number of leaves 10WAT
T_0	16^b	22^b	6^a	8^a
T_1	25^a	27^a	10^a	12^a
T_2	25^a	30^a	10^a	12a
T_5	28^a	30^a	12^a	13^a
T4	30^a	33^a	13^a	13^a
T_5	31^a	33^a	13^a	14a
S.E±	0.93	0.93	0.07	0.07

Means with the same letters along the column are not significantly different ($p<0.05$)

Table 3. Mean onion bulb weight and bulb yield per hectare affected by IYSV

Treatments	MBW(g) 7WAT	MBW(g) 10WAT	Number of onion bulbs	Bulb yield (t ha^1)
T_0	5.477^a	2.0117^a	7^d	7.7^d
T_1	24.443^{bc}	3.0917^a	12^{bc}	$12.2b^c$
T_2	31.607^a	26.0933^a	19^a	15.8^a
T_3	26.052^b	51.0725^a	20^b	13.0b
T_4	22.531^c	33.2067^a	31^c	11.3^c
T_5	15.477^d	34.0317^a	36^a	16.7^a
S.E±	1.14	0.69	0.57	0.57

Means with the same letters along the column are not significantly different ($p<0.05$), MBW = mean bulb weight, MBD = mean bulb diameter

The lowest bulbs weights (2.0g) were recorded in control T_0 and T_1 (3.1g) (Table 3). Similarly there were no significant differences in onion bulb tons per hectare between $T_5$and T_2at 10 WAT (16.7 and 15.8 tons/ha) respectively (Table 3). Highest bulb diameter (31.6cm) was recorded in T_2 at 10 WAT, which was significantly different from T_3 (26cm), T_4 (22cm) and T_5 (15cm). The smallest bulb diameter of 2.0cm at 10 WAT was recorded in the control (T_0).

DISCUSSION

Results obtained in this study showed that application of organic manures during onion production significantly reduced IYSVD incidence. These observations agree with that of Pammel (1989) which indicated an increase in the vigor and reduction of disease incidence in maize plants. Gamliel *et al.* (2012) further reported that, application of organic manure to the soil with high levels of organic matter have been shown to

Our results emphasize the need for exercising strict quarantine measures for preventing spread of IYSVD between towns and have also identified the need for incorporating the use organic agricultural practices with resistance breeding in developing onion varieties with broad spectrum resistance to IYSV.

Also the rate of IYSVD incidence obtained in this study suggests that Thrips management will not only provide a solution to current IYSVD pandemics, but in addition, will significantly reduce the likelihood for the emergence of new epidemics likely to be caused by variant isolates.

Conclusion

From results obtained in this investigation it may be concluded that combined application of 25% poultry manure and 75% FYM may be recommended in reducing the incidence of IYSVD and increased onion bulb yield.

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