INTEGRATED MANAGEMENT OF YELLOW MOSAIC DISEASE OF JUTE

A thesis

By

SAYED ZAHUR AHMED

Examination Roll No. 05. Ag. P Path. JD 33 M

Registration No. 26708

Session: 1999-2000

Semester: July-December 2006

MASTER OF SCIENCE (MS)

IN

PLANT PATHOLOGY

DEPARTMENT OF PLANT PATHOLOGY

BANGLADESH AGRICULTURAL UNIVERSITY

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DEDICATED TO

MY

BELOVED PARENTS

THE ARCHITECT OF MY MEANING FULL

LIFE

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The author

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ABSTRACT

A field experiment was conducted to investigate the effect of some integrated management practices to minimize jute yellow mosaic disease. The practices were done with plant extract inorganic fertilizer and amaranthus (inter cropped) in combination or singly.The practices were employed at natural condition and placed randomly with nine treatments. The treatments were: T_1= Intercropping with amaranthus, T_2= Spraying with garlic extract (1: 100 dilutions), T_3= Spraying with neem extract (1:100 dilutions), T_4= Spraying with 0.2% urea solution, T_5= Intercropping with amraranthus plus spraying garlic extract, T_6= Intercropping with amaranthus plus spraying neem extract, $T_{7=}$ Intercropping with amaranthus plus spraying 0.2% urea solution, T_8= Roughing out of symptom bearing plant(s) and T_9= Control (Non treatment). Data were collected at different growth stages (30 DAE, 60 DAE and 90 DAE) and analyzed as per the design of experiment to determine the variance and significance. The highest percentage of mosaic incidence was recorded in the control treatment (T_9) and the lowest incidence was in T_7 treatments. Among the treatments intercropping with amaranthus plus spraying 0.2% urea solution (T_7) showed the best performance in terms of increasing of yield components and yield. The second highest response was found in T_5 and T_6. However, all the treatments were found to be significantly profitable compared to the control (T_9), indicating the usefulness of the treatments to be integrated to formulate a IDM program for a healthy and profitable jute cultivation.

INTRODUCTION

Jute (*Corchorus olitorius* L) is one of the most important fibre and cash crop of Bangladesh which still plays a vital role in the national economy in Bangladesh as it is still the third important commodity for export, earning foreign exchange. From agriculcultural point of view jute is still the golden fibre of Bangladesh. Its golden fibre is used for making fabrics, gunny bags, carpets, ropes and household products. Jute sticks are used in producing partex board, the young green leaves are consumed as highly nutritions and palatable vegetable and the defoliated green plants are used in producing high grade paper pulps. Thus, it still has a great potential.

Yellow mosaic is one of the most important diseases of jute. This viral disease causes loss of yield and affects quality of fibre. The disease is seed-borne. The infected plants raised from infected seeds gave 16.8-65.9% loss in fibre yield (Biswas, *et al.* 1989).

Infected seeds may not germinate, seed transmitted infected seedlings may face early death and often the plants escaping such as death act as source of inoculum for secondary spread of the causal agent through its vector in the field. Thus jute mosaic virus can spread through infected seeds and vector *Bemisia tabaci* in an epidemic form causing substantial loss in a cropping season. The disease causal agent has been reported to be transmitted through grafts, seed and pollen (Ghosh and Basak, 1951, Ghosh, 1957 and Ashrafuzzaman 1999). Whitefly transmission of the disease has been reported by Verma, Rao and Capoor (1966); Ahmed (1978) *et al.* (1980).

The attack by the whitefly results in reduced plant vigour due to loss of plant sap. Severe infestation of the whitefly may result in the defoliation of the plants. Indirectly the whitefly causes reduction of yield by transmitting viral pathogens and through sucking of sap and secretion of wax and honeydew and expressing mosaic symptoms which reduce the green area of the plant (Alam *et al.* 1998).

Transmission of the causal agent from infected to the healthy plants by the insect vector *Bemisia tabaci* has been reported by Ahmed (1978) and Verma (1966). They reported that the mosaic symptom on leaves of healthy plants appeared after 23 days of feeding by *B. tabaci.*

That the pathogen could only be seed transmitted through capsularies plants was first reported by Ghosh and Basak (1951). This report was supported by another report (Anonymous, 1959-70) submitted to PCJC, Dhaka and lately by Ashrafuzzaman 1999.

Jute yellow mosaic is one of the most important diseases resulting loss of yield, yield contributing parameters and quality of fiber. Limited Research work on prevalence and control of the yellow mosaic of jute has been published in Bangladesh. Islam *et al.* (1993) looked into the severity and source of jute leaf mosaic virus on white jute. They worked with white jute (Desi jute) cultivars D-154 CVE-3, CVL-1 and CC-45 collected from four different sources such as BJRI, BADC, local market and jute farmers. They observed that the mosaic or chlorotic symptom of white jute resulted in fiber loss. The seed precaution could reduce this seed-borne transmission.

For the development of an integrated disease management system, our entire management programme has to draw special attention to minimize the effect of jute mosaic disease.

The present study has been designed to find out an effective and economic management of jute yellow mosaic disease useful to farmer's practice for sustainable agriculture, with the following objectives:

1. Study of the jute yellow mosaic disease.
2. Observation of some potential components of integrated treatments on jute yellow mosaic disease.
3. To formulated an integrated management practice controlling yellow mosaic disease.

CHAPTER 2
REVIEW OF LITERATUR

REVIEW OF LITERATURE

Jute is known to be attacked by different pathogens. Leaf yellow mosaic is one of the most important jute diseases due to loss of yield, and deterioration of quality of fibre to a considerable amount. Very limited research works have been conducted on evaluation of different non toxic control measures of jute yellow mosaic disease. Therefore, literature on management practices for controlling jute yellow mosaic disease is rare in Bangladesh. Relevant literature on the disease symptoms and cultural management practices like insecticidal spray, roughing, field sanitation, top dressing of nitrogenous fertilizer and mulching with straw on prevalence of jute yellow mosaic disease are reviewed sorted and presented in this chapter.

2.1 Symptoms

Finlow (1917) first observed the yellow and light yellow patches on the leaf of jute leading to variegated appearance and he applied the term 'chlorosis' to describe the phenomenon. Since than, the term 'chlorosis' has been used by later workers dealing with this problem of jute.

Finlow (1939) reviewing the works on jute, described 'chlorosis' as a morphological imperfection' and suggested concentrated attention to study this phenomenon.

Ghosh and Basak (1951) reported that the symptoms of the so called 'chlorosis' of jute sometimes remain latent in the early stages and appear afterwards. Cases of gradual complete recovery from 'chlorosis' and associated symptoms are also reported. When the attack was mild, growth in general might be slightly arrested but flowering and pod production appeared normal. In case of severe attack the plants remained stunted and ultimately died. Those which survived till the flowering time usually failed to produce pods and if at all formed failed to develop seeds. As mosaic type is also observed, the authors suggested that the term 'leaf mosaic' should be used to denote this graft transmissible disease.

Ahmed and Lange (1998) observed that the symptoms may start to appear as yellow sports on cotyledons following severe mosaic on all following leaves or on the 3rd or 4th true leaves.

2.2 Causal agent and its mode of transmission

Banerjee (1924) said that chlorosis in jute was not due to any virus and by crossing chlorotic and nonchlorotic plants he found that the mode of inheritance of the disorder was not medelian.

Bewden (1950) cited known cases of transmission of the causal virus through seed of the infected plants of different species.

The observations were made on the segregating generations of the crosses between chlorotic and non chlorotic disorder (Anonymous, 1922-23). Banarjee 1924 and Anonymous, 1953 who observed that the segregation in successive generations did not follow the mandelian law.

Anonymous (1959) reported about 18%-46% loss in fibre yields from leaf mosaic affected plants than that obtained from healthy plants depending upon the percentage of affected plants and severity of symptom.

Bist and Mathus (1964) observed the occurance of two types of leaf mosaic disease caused by two strains of the same virus. They also indicated that jute virus could be transmitted to kenaf.

Ahmed (1968) found the incidence of leaf mosaic affected plants in various percentages in jute fields of different districts of Bangladesh. Incidence of 100% affected plants was reported from Rangpur in 1966 while 59.3% was reported from Bogra in 1963.

Sastry and Singh (1973) have stated that when the plants are infected within 20 days of planting the loss may be up to 92% while infections in 35 and 50 day old crops suffer 74%, 20% losses respectively. That is, initial care against vector transmission up to first two months reduces the number of infected plants to a considerable level.

Ahmed (1978) reveled that two species of jute, namely *Corchorus capsularis* and *C. olitorius* are grown commercially throughout the world. Attempts have been made to grow the fibre crop also in Pakistan. However, survey in the Pubjab region revealed that *C. capsularis* was seriously affected by a yellow mosaic disease. The disease exhibited viral characteristics. It was transmitted by grafting and whitelfly (*Bemisia tabaci*), but not by mechanical means, dodder, seed, soil or nematodes. There was no transsovarial transmission by whitefly, suggesting that the pathogen survived in alternate host plants. The disease was innocuous to *C. olitorius* and the wild jute *C. trilocularis.*

Givord (1978) observed that virus symptoms on *Corchorus olitorious, Hibiscus sabdariffa, Urena labata, Borreria intricans* and *Blighia welwitschii* in fields of *Habiscus esculentus.* Symptoms, insect transmission, host range, electron microscopy and serologic tests showed *Hibiscus esculentus* mosaic virus to the cause of the disease which means that corchorus acts as alternate host of okra mosaic virus.

Quite a few attempts have been made to identify and characterize the pathogen. Lange made investigations of the jute mosaic problem at the Danish Govt. Institute of seed pathology (DGISP) during 1979-1980. They observed that the symptoms might start to appear as yellow spots on cotyledons of seedlings raised from infected seeds, usually followed by severre mosaic on all the forthcoming leaves or on the 3rd and 4th true leaves or later. They observed that a conspicucous fine light yellow mottling first appears on young leaves. As the disease progresses the leaves show typical light green to yellow mosaic symptoms with bright yellow irregular areas interspersed with deep green inland which are curved, usually convexly.

Mitra *et al.* (1984) electron microscopically examined the viral infected jute leaves following modified leaf-dip method. The viral particles were characteristic in shape and size. The particles were spherical in shape and measured about 23 nm in diameter.

Rabindran *et al.* (1988) observed at the Tamil Nadu Agricultural University farm that in the infected plants, leaves were crinkled, leathery and at the top of the plants needle-like floral organs were deformed. Internodes were shortened and the branches proliferated. The disease could be graft-transmitted to *Corchorous olitorious* but not to *Seasamum indicum* or *crotalaria juncea.* It was through that the disease may be caused by a mycoplasma-like organism.

Biswas *et al.* (1989) studied the effect of leaf mosaic disease on loss of yield and quality of jute fibre *Corchorus capsularis* (var. D-154) with the infected plants ranging from 10.0 to 100.0%. The infected plants raised from infected seeds gave 16.8 to 65.9% loss of fibree yield. Healthy plants infected secondarily at pre flowering stage showed 11.4% fibre loss. With the increase of percentage of infected plants green weight and plant height were reduced. Chemical analysis of fibre from 100.00% healthy and 100.00% diseased plants was done. It was observed that leaf mosaic infected fibres had lower amount of cellulose (40-02); lignin (12.0) and pectin (1.82); compared to normal indicating weaker strength of fibre obtained form diseased plants.

Johnsen *et al.* (1995) reviewed about significance of seed transmission, virus entry and localization in the seed, heat resistance to seed transmission, environmental factors, and disease symptoms limiting seed transmission, virus host population and viral determinants of seed transmissibility.

Haque *et al.* (1998) reported about the incidence of leaf mosaic and its effects on yield contributing characters (plant height, base diameter, plant weight and fiber weight) which were studied in four agroecological zones of Bangladesh namely Manikganj, Rangpur, Chandian and Kishoreganj.

Das *et al.* (2001) stated that growing on test was conducted in aluminum trays and photographic cassette holders to determine the germination and seed transmission of jute leaf mosaic agent using two corchorus capsularis culvitars. The test cultivars (D-154 and CVL-1) were growing in successive two years in a net house. Seeds collected form early-infected plants were used in the second year. Significantly higher percentage of seed transmission was obtained in the second year. They also observed that the agro-ecological factors influenced the occurrence of the disease.

2.3 Transmission of the virus

Ghosh and Basak (1961) observed that the progenics of a chlorotic jute plant almost always segregated into two groups, one showing chlorotic symptoms and the other apparently normal and green. The ratio of the chlorotic to the non chlorotic progeny was never the same for any two selections. They also observed that 10 chlorotic progeny was never the same for any two selections. They obtained 10 chlorotic progeny out of 12 from a chlorotic selection. The results indicated that the virus is seed transmitted. In order to find the relative importance of the pollen and the embryo sac in transmitting the virus they made a cross between chlorotic and nonchlorotic individuals. The presence of chlorotic plants in the F_1 from a cross between non chlorotic female and chlorotic male parent and crossed, the result indicated that the pollen can carry the virus. They claimed to have found additional evidences which indicated that the disease was due to a virus and that the embryo sac can carry the virus.

Ghosh and Basak (1961) reported that the disease was graft transmissible but they failed to induce chlorosis by sap inoculation. Their work suggested that the disease was due to a virus which could only be transmitted took place through seed. Moreover, they presumed that transmission of mosaic symptoms takes place through female parent in *Corchoruos capsularis* and *C. olitorius* jute was immune or rarely affected. They noted the sporatic occurrence of chlorosis in the field which did not further increase in number of but in case the population in raised from seeds collected from only affected plants, transmission was as high as 81.09%.

Conti (1996) reported that white fly vector's recognized hosts include *Trialeurodes vaporaiourm, T. abutilonea* and possibly, *Barabemisia myricae.* They mostly infect plants in the chenopodiacease, Compositae, curciferae, cucurbitaceae and solanaceae, causing symptoms such as chlorotic spots, yellowing or chlorosis, and thickening, brittleness and down ward curling of leaves. Transmission has been obtained by grafting. They author did not observe transmission by sap or aphid inoculation, or by contact or through seed. The white fly vector (*Bemisa tabaci*) can transmit with acquisition and inoculation feedings of at least 5 minutes but the transmission rate increases as feeding periods are increased.

Verma *et al.* (1996) reported about the white fly (*Bemisia tabaci*) transmission of the disease from affected plants to healthy plants. They were successful to transmit leaf mosaic disease from affected to healthy plants in presence of white fly within insect proof cage. Mosaic symptom in this experiment began to appear on leaves of healthy plants from 23 days after release of white fly (*Bemisia tabaci*).

Sultana *et al.* (1995) studied the seed transmission of the causal agent of jute leaf mosaic disease of *C. capsularis* cv. D-154 by doing reciprocal crosses between healthy and infected plants. They obtained 22 to 23% hybrid progenies with leaf mosaic symptoms in F_1 generation, using healthy female as against up to 72% progenies with symptoms in reciprocal crosses when pollen from infected plants was used. Hybridization between the infected female and infected male parent showed 94% infected progenies.

2.4 Environment requirements for whitefly vector

Horowitz (1986) found significant drop of White fly population level at heavy rain condition.

"White fly population varies form season to season. It depends on temperature, rainfall, humidity, fog etc". Echelkraut and Cardona (1989). They also reported that dry conditions are more favourable for white fly, *B. tabaci,* than those of high precipitation.

Salinas (1994) reported that temperature, relative humidity and the number of rainy days had a highly significant correlation with the adult population. A highly significant correlation was also noted between relative humidity and egg counts.

Salinas and Sumalde (1994) reported that high temperature and rainfall appeared to have a disruptive effect on the population of white fly.

Gupta and Keshwal (2002) reported about a study on mung bean yellow mosaic virus on soybean which was carried out with respect to different events prior to development of epidemics due to inoculum build up in reservoir hosts. Long term surveillance study on disease flare-ups revealed that fields near irrigation canals, water points, low lying areas and foot-hills had high disease incidence compared to the unirrigated field plains of Madhya Pradesh, India. Soyabean cv. JS 81-335 and *Corchorus olitorius* were found to act as bridge host in bringing inoculum of yellow mosaic virus from mung bean to soyabean. Plant species such as *Paracalyx* scuibiosus was found to act as reservoir host of yellow mosaic inoculum. In addition *Alternornthera sessilis* [*Alternathere sessilis*] and *Sida rhombifolia,* the weeds hosts recorded, were found to help the multiplication and spread of inoculum. The study of parameter on yellow mosain virus and whitefly population revealed that the rate of disease development was high when maximum temperature and relative humidity ranged between 31°C to 36°C and 62.75%, respectively.

2.5 Treatment and management of the disease

At high contact rates rouging both latently infected and infectious plants was advisable. With disease present, the equilibrium level of healthy plants did not depend on replanting rate. There was a trade off between rouging and replanting in designing optimum disease management from field studies on 3 plant virus diseases. The model indicated that eradication was achievable with realistic rouging intensities.

Chan and Jager (1984) developed a mathematical model of the dynamics of disease management by rouging (removal) of infected plants and replanting with healthy ones. Roughing only in the post infectious category did not confer an advantage. At low contact rates, rouging only when plants become infected was found sufficient to eradicate the disease.

Wislocka and Cuesta, (1987) investigated at sites, the effectiveness of traditional, chemical and simplified method of roughing in limiting virus spread. In the simplified method, the aerial parts of rouged diseased plants were leaf on the ridges and aphids were killed with the systemic insecticides Bi-58 (dimethoate) or with pirimor (pirimicarb), acting by contact and penetration. They observed that in small plots, traditional roughing without killing aphids was the most effective. In experiments on a commercial scale, there were no significant differences in infection of seed tubers with potato Y poty virus and potato roll luteovirus between the different rouging methods. CHO (1989) discussed the Hawaiian agricultural ecosystem. They reviewed the history of TSWV in Hawaii and discussed a multidisciplinary control programme. The programme involved TSWV identification and detection. TSWV vector-host relationships, chemicals control of the vector (*Franklinielle occidentalis*), search for resistant germplam and cross-protection against severe strains of TSWV. Current research (the use of molecular biology and monoclonal antibodies) are also discussed in the publication.

Jayraj and Vidhyasekran (1990) discussed management of aphids (*Myzus persocace, Pentalonia nigronervosa* and *Aphis gossypii*). Leaf hoppers (*nephotettix* spp.) and white files (*Bemisia tabaci*), with an aim to control plant virus diseases in a review with comparative study of various chemical and physical methods and their respective merits.

Mandahar *et al.* (1990) advocated the management of plant virus diseases by cultural practices for repelling of insect vectors, indexing and certification programs, cross protection (immunization), disease forecasting and quarantine regulations.

Tripathi and Trapathi (1982) investigated the antiviral activity of 17 plants extracts against been common mosaic virus. The extracts of *Azadirchata indica* was found to be most potent in reducing the infectivity of the virus.

The pesticidal actions of neem and certain indigenous plants and weeds of Bangladesh were studied by Islam (1983). He reported that oil of neem (*Azadirachta indica*) as well as extracts of leaves and seeds of *Azadirachta indica, Melia, azedarach, Ammora ruhituka,* and *Annona reticulates.* With hexane, diethyl ether, 95 percent ethanol and acetone showed potentiality as antifeedant for the control of brown rice plant hopper (BPH), green rice leaf hopper (GRL), rice hispa and lesser rice weevil. Extracts of hexane significantly deterred the feeding by tree species of rice insects; he also observed that young seedlings of rice sprayed with 8-12% of crude and emulsified neem oil significantly reduced feeding by brown plant hopper and green rice leaf hopper.

Saena and Khan (1984) found that the feeding *Nephotettix virsescens* was disturbed by neem oil. They observed that as the concentration of neem oil increased the feeding on phloem decreased by *Nephotettix virescens* accompanied by increasing feeding upon system.

Surichandrasevan and Narayanasamy (1987) carried out a research on the inhibition of Potato virus Y-infection on chillli by plant extract. Extracts from disease free leaves of 22 non-host species were tested against Potato Y-virus in inoculated chilli plants. Inhibition from *Besella rubra* was most effective. It is suggested that the resistant plants may contain potent antiviral compounds.

The antiviral activity and physical properties of the extracts *Azadirachta indica* L. was studied by Singh *et al.* (1988). *A. indica* extracts inhibited the infection of cowpea mosaic virus in *Chenopodium amaranticolor*. They reported that the inhibitor was heat stable, non dialyzable through cellopane, resistant aging after 25 days and desiccation after 50 days but showed appreciable loss of activity on dilution. They pointed out that the virus inhibitory activity of this extract was lowered in strong acidic and basic solutions. The test extracts both from the leaves and bark did not show inhibitory effect on virus inoculated plants but were very effective when applied to the leaves prior to inoculations.

Rahman (1995) conducted an experiment on five different plant extracts and reported that Garlic clove (1:16) and its scales (1:8) and onion bulb (1.32) gave the best performance among all the treatments he used. He also reported that garlic clove (1:2) exhibited best performance among all the treatments in preventing yellow vein mosaic of okra and their efficacy was comparable to Diazinon.

Lee (1972) reported that chilli, cocoyam, cucumber, French bean, ginger, groundnut, okra long bean (*Vigna sp.*), maize and tomato were intercropped within lines of pineapple on peat soil. All intercropping except cocoyam, French bean and maizedid show potentiality.

Prabhakar *et al.* (1985) in 2-year trails, 8 intercropping combination combinations involving *Capsicum* or okra intercropped with beetroots, peas, onions and knol-khol (Kholrabi) were compared for nutritional value with the same crops in monoculture. Higher yields, in nutritional terms were obtained with intercropping, particularly when beetroots, peas or knoll-khol were grown with okra or *Capsicum.*

Prabhakar and Shukla (1991) found that intercropping okras with radishes or *Phaseolus vulgaris* in a sandy loam soil gave greater returns than growing okras alone. The following returns were obtained: 9489, 12438, 8201, 3071 and 11468 Rs. /ha for okras + *P. vulgaris,* okras + radishes and okras, *P. vulgaris* and radish alone, respectively fertilized with 100 kg N/ha 44 kg /ha and 42 kg K/ha. These values increased to 12886, 19478, 10807, 7305 and 17546 Rs/ha, respectively, with 150 kg N/ha, 66 kg /ha and 42 kg/ha.

Amma *et al.* (1991) studied on raising amaranthus as mixed crop on the yield of bhindi. There were 4 treatments, viz. (1) sowing *Amaranthus* sp. cv. Co. 1 seven days before okra cv. Parbhani kranti (2) sowing Co. 1 three days before okra, (3) sowing Co. 1 together with okra and (4) okra alone. They observed that the *Amaranthus* was successful; especially in treatment (3) which gave the higher yield of 10.358 t/ha due to low incidence of okra mosaic compared with 9.664 t/ha in (4). They also suggested that the net income for both crops was also highest in (3) and lowest in (4). Border effects due to the accumulation of whitefly vectors (*Bemisia tabaci*) on the wind exposed field borders under the influence of prevailing wind. This result was pronounced environmental gradients of disease. They suggested that temporal patterns of viral spread were drived by the sinusoidal fluctuation of temperature over the year which corresponds with changes of whitefly population.

Orkwor *et al.* (1994) conducted an experiment to find out the importance of tropical root crops in developing economy. In field trials, yam was intercropped with maize, okra and sweet potato in Umudike, Nigeria. They suggested that yam tuber yield was positively and significantly correlated to increase ground coverage by the canopy formed by sweet potato plants. They also reported that okra yield was higher in intercropping system compared with producing okra only.

Olsantan (1998) conducted field experiments with Alfisols in Nigeria between 1991 and 1993 to determine the residual effect of maize and cowpea on the growth, pod yield and N response of a succeeding okra crop. Cowpea and maize were grown alone with 30 and 60 kg/ha of N, P and K, respectively, or intercropped with 60 kg/ha as a basal dressing. The proceedings crops had a significant effect on soil nutrient changes. Okra growth and yield, and N response of okra. Cowpeas increased the N, P and K status of the sol in both sole and mixed stands, compared with sole maize. Leaf area, pod weight and marketable pod yield of okra after sole cowpeas or the maize/cowpea intercrop were all significantly higher than that of sole maize.

MATERIALS AND METHODS

Materials and methods of the experiment were used as follows:

3.1 Experimental site and period

The field experiment was conducted in the field laboratory, Department of Plant Pathology, Bangladesh Agricultural University (BAU), Mymensingh, during the period from March 2006 to August 2006.

The experimental area was under subtropical climate characterized by heavy rainfall during April to September. The experimental field was situated at a medium high land with sandy loam soil having soil pH 6.5. The experimental site was under the AEZ upper Brahmaputra flood plain (SRDI, 1990).

3.2 Collection of seeds

Seeds were collected from the breeding division of Bangladesh Jute Research Institute (BJRI), Dhaka.

3.3 Variety used

Corchorus olitorius was used for the study.

3.4 Land preparation

First ploughing, second ploughing and final ploughing were done with a power tiller on 17th, 23th and 30th March 2006 respectvely.The land was ploughed in criss-cross methods for several times so that the soil would come to a good tilth condition. Every ploughing was followed by laddering to break up the soil clods and to level the surface. Weeds, crop residues and other rubbish were removed from the field. After the final land preparation, plots were prepared as per layout of the experiment it designs and seed were sown.

3.5. Manuring and fertilization

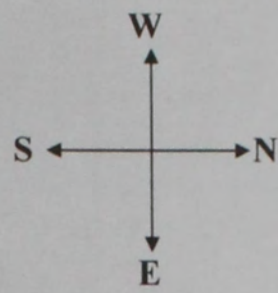
Manures and fertilizers were applied to the experiment field as per recommended rates stated below:

Manures/ Fertilizers	Kg/ hectare
Cowdung	4,000
Urea	100
TSP	30
MP	50

Total amount of cowdung was applied before 2 weeks of sowing and one half of urea, full dose of TSP and MP were applied at the time of final land preparation. Rest of Urea was applied as side dressing after 45 days of sowing.

3.6 Design of experiment

The experiment was laid out in a Randomized Completely Block Design (RCBD). The experimental field was divided into three Blocks each block hearing into nine plots. The plot size was 2.5 X 2.5 m.Treatments were assigned to each block at random. The space between the blocks and between the plots was 25 cm.



3.7 Layout of experiment

R_1T_8	R_2T_7	R_3T_5
R_1T_4	R_2T_3	R_3T_7
R_1T_7	R_2T_8	R_3T_1
R_1T_9	R_2T_5	R_3T_9
R_1T_2	R_2T_9	R_3T_4
R_1T_5	R_2T_1	R_3T_8
R_1T_6	R_2T_6	R_3T_2
R_1T_3	R_2T_2	R_3T_6
R_1T_1	R_2T_4	R_3T_3

Figure 1: Layout of the field experiment (RCBD)

3.8 Treatments

The treatments were as follows:

1) T_1 = Intercropping jute with of Amaranthus
2) T_2 =Spraying with garlic extract (1: 100 dilution)
3) T_3 =Spraying with neem extract (1: 100 dilution)
4) T_4 =Spraying with 0.2% urea solution
5) T_5 = Amaranthus + garlic extract
6) T_6 =Amaranthus + Neem extract
7) T_7 =Amaranthus + 0.2% solution
8) T_8 =Roughing out of symptom bearing plant
9) T_9 =Control

3.9 Sowing of seeds

Seeds were sown on the 30th March 2006. Line sowing method was followed with a seed rate of 8 kg/ha. The distance maintained between line to line was 20 cm and plant to plant was 10 cm by thinning out seeding during the first weeding operation at 15 DAE.

3.10 Production technology

Weeding schedule was prepared to keep the plots weed free and was done at 15 days intervals from the days after sowing for three times. These are 15th April 2006, 30th April 2006 and 15th May, 2006.

Roughing and field sanitation was done the plots assigned in symptom bearing seedlings at 15 days interval according to the scheduled treatment (15, 30, 45 and 60 DAE). Top dressing of Nitrogenous fertilizer (Urea) was applied at 15 days interval (15, 30, 45 and 60 DAL) @ 50.6 kg/ha only to assigned plots.
The control plots were left in natural conditions without applying any treatment.

Jute plants were cut on 16^{th} August 2006. Leaves and green stricks were weighted and left in the field for 3 days for defoliation. Then, bundles of sticks were rottened in water for 20 days. After adequate rottening, the fibres were extracted, dried and weighted and sticks were also weighted.

3.11 Collection of Data

After germination, the emerged seedlings were observed according to the schedule and recorded the number of symptom bearing and healthy seedlings. It was continued upto to the harvest of the crop. Following observations were also recorded from the field.

3.12 Assessment of leaf mosaic incidence

The experimental plots were observed regularly for the appearance of viral mosaic symptom. The incidence of mosaic was recorded three times. Records were taken at 30 DAE, 45 DAE and 60 DAE. The incidence of jute yellow mosaic diseases was calculated as follows.

$$\% \text{ diseased plants} = \frac{\text{Number of infected plants in each plot}}{\text{Total number of plants in each plot}} \times 100$$

3.13 Insect population counting

The number of white files (*Bemisia tabaci*) was recorded per plant at 15 days intervals before the application of insecticides and rouging operation. Collection of white fly was done with the help of a plastic Beljar. A contact insecticide was applied as aerosol in the Beljar for killing the vector.

3.14 Data on yield parameters

Jute was harvested at full mature stage, 10 healthy and 10 diseased plants were selected at random from each unit plot for the collection of data in following parameters:

Parameters

1) Number of infected and healthy plants per plot
2) Number of infected and healthy leaf per plant(average of 10 plants/treatment)
3) % diseased plant/plot
4) Height of diseased plant and healthy plant.
5) Diameter of the stem healthy and diseased plant 1 foot above ground
6) Yield of fiber and stick (healthy and diseased plant).

3.15 Weather data

The monthly mean of daily maximum, minimum and average temperature, relative humidity, monthly total rainfall (mm) and sunshine hours received at the experimental site during the period of the study have been collected from the weather yard. Department of Irrigation and Water Management, BAU, Mymensingh.

3.16 Analysis of data

Data were organized, converted if necessary and analyzed statistically followed by factorial experiment in RCBD to determine the effect of management practices on the incidence of vector population and disease occurrence as well as on the growth yield and yield component of jute. The mean values of the individual treatments were compared with Duncan's Multiple Range Test (DMRT) with the help of a computer.

RESULTS

The results of this study on the performance in respect of integrated management practices against jute yellow mosaic disease have been presented in this chapter.

4.1 Effect of treatments on the number of infected plant and healthy plant at different days after emergence (DAE)

The result of effect of treatments on the number of infected plant (plate 3B) and healthy plant (plate 3A) at different days after emergence are presented in table-1.

The number of infected and healthy plant was significantly influenced by the treatments at different days after emergence (DAE).

At 30 DAE, the lowest number of infected plant per plot was found (19.00) in intercropping with amaranthus plus spraying 0.2% urea solution (T_7).This was statistically similar to that of T_6 (amaranthus with neem extract).On the other hand control treatment was found to highest (256.7) number of infected plant.

At 60 DAE, the lowest (14.33) number of infected plant per plot was found in same treatment T_7. This was statistically similar to that of T_5 (amaranthus with garlic extract). On the other hand control treatment was found to highest (258.3) number of infected plant.

Again at 90 DAE, the lowest (23.67) number of infected plant per plot was found in intercropping with amaranthus plus spraying 0.2% urea solution. This was statistically similar to that T_8. On the other hand control treatment was found to highest (268.3) number of infected plant.

At 30 DAE, the highest (433.7) no. healthy plant per plot was found in the Plots with Intercropping with amaranthus plus spraying 0.2% urea solution .On the other Hand the lowest (193.7) no. of healthy plant was found in treatment control.

At 60 DAE, the highest (423.3) no. healthy plant per plot was found intercropping with amaranthus plus spraying 0.2% urea solution (T_7).This was statistically similar to that of T_5 (amaranthus with garlic extract).On the other Hand the lowest (180.00) no. of healthy plant was found in control intreatment

Again at 90 DAE the highest (414.0) no. healthy plant per plot was found Intercropping with amaranthus plus spraying 0.2% urea solution (T_7).On the other Hand the lowest (167.0) no. of healthy plant was found in treatment T_9. This was statistically similar to that of T_8 .

Between the first two field inspection at 30 DAE and 60 DAE some of the early infected (probably seed borne) plants died and withered. These was no treatment difference apparently in this phenomenon.

Table 1. Effect of treatments on the number of infected plant and healthy plant/plot at different days after emergence (DAE)

Treatment	Number of infected plant/ plot			Number of healthy plant/ plot		
	30 DAE	60 DAE	90 DAE	30 DAE	60 DAE	90 DAE
T_1	24.33 c	18.33 b	98.67 b	425.3 b	413.7 c	332.3 f
T_2	23.33 cde	18.33 b	86.00 c	425.3 b	415.7 bc	344.3 e
T_3	24.00 cd	17.33 bc	69.67 d	425.7 b	416.7 bc	363.3 d
T_4	21.00 def	17.33 bc	59.67 d	427.7 b	416.7 bc	372.0 d
T_5	20.33 ef	15.00 c	35.67 f	430.00 ab	422.7 a	399.7 b
T_6	19.67 f	17.00 bc	47.33 e	428.3 b	417.7 b	387.0 c
T_7	19.00 f	14.33 c	23.67 g	433.7 a	423.3 a	414.0 a
T_8	244.3 b	19.67 b	23.33 g	219.00 c	199.3 d	172.7 g
T_9	256.7 a	258.3 a	268.3 a	193.7 d	180.00 e	167.0 g

In a column, figures having common letter (s) do not differ significantly at 5% level by DMRT.

The treatments were as follows:

1) T_1 = Intercropping jute with of Amaranthus
2) T_2 =Spraying with garlic extract (1: 100 dilution)
3) T_3 =Spraying with neem extract (1: 100 dilution)
4) T_4 =Spraying with 0.2% urea solution
5) T_5 = Amaranthus + garlic extract
6) T_6 =Amaranthus + Neem extract
7) T_7 =Amaranthus + 0.2% solution
8) T_8 =Roughing out of symptom bearing plant
9) T_9 =Control

4.2 Effect of treatments on the number of infected leaf and healthy leaf at different days after emergence (DAE)

The result of effect treatments on the number of infected leaf and healthy leaf at different days after emergence is presented in table-2 and plate-1(A, B, C and D).

The number of infected and healthy leaf was significantly influenced by the treatments at different days after emergence (DAE). At 30 DAE, the lowest (9.333) number of infected leaf per plant was found in plots housing intercropping with amaranthus plus spraying 0.2% urea solution (T_7). On the other hand, T_9 treatment was found to have highest (17.33) number of infected leaf which was statistically similar to that of T_8 (roughing out of symptom bearing plant).

At 60 DAE, the lowest (8.667) number of infected leaf per plant was found in the same treatment (T_7). This was statistically similar to that of T_5 (amaranthus with garlic extract) and T_6 (amaranthus with neem extract). On the other hand, In the T_9 treatment to highest (29.67) number of infected leaf was found.

Again at 90 DAE, the lowest (17.33) number of infected leaf per plant was found in intercropping with amaranthus plus spraying 0.2% urea solution (T_7). On the other hand control treatment was found have to the highest (46.33) number of infected leaf.

At 30 DAE, the highest (86.33) no. healthy leaf per plant was found under intercropping with amaranthus plus spraying 0.2% urea solution (T_7). On the other Hand the lowest (23.33) no. of healthy leaf was found in the treatment T_9.

At 60 DAE, the highest (131.7) number of healthy leaf per plant was found intercropping with amaranthus plus spraying 0.2% urea solution (T_7).This was statistically similar to that of T_5 (amaranthus with garlic extract).On the other Hand the lowest (25.00) no. of healthy leaf was found in treatment $T_{9.}$

Again at 90 DAE, the highest (120.3) no. healthy leaf per plant was found under the treatment intercropping with amaranthus plus spraying 0.2%urea solution (T_7). This was statistically similar to that of T_5 (amaranthus with garlic extract). On the other Hand the lowest (14.67) no. of healthy leaf was found in control treatment.

Between the first observation and the second at 30 DAE and 60 DAE respectively some of the leaves which suffered from chlorosis were found to the converted into the stem of the plant.

Table 2. Effect of treatments on the number of infected leaf and healthy leaf at different days after emergence (DAE)

Treatment	Number of infected leaf/ plant			Number of healthy leaf/ plant		
	30 DAE	60 DAE	90 DAE	30 DAE	60 DAE	90 DAE
T_1	13.00 b	13.67 c	30.33 bc	76.33 d	125.3 c	81.67 e
T_2	13.00 b	11.33 d	25.33 bcd	77.33 cd	126.0 bc	87.67 d
T_3	12.33 bc	11.00 de	25.00 bcd	78.33 cd	126.7 bc	97.00 c
T_4	10.67 bc	9.667 def	31.00 bc	78.67 cd	127.3 bc	97.67 c
T_5	10.33 bc	8.667 f	21.67 cd	81.67 b	130.7 a	115.7 a
T_6	10.67 bc	9.00 ef	27.33 bc	80.33 bc	128.3 b	110.0 b
T_7	9.333 c	8.667 f	17.33 d	86.33 a	131.7 a	120.3 a
T_8	17.00 a	18.33 b	33.00 b	27.67 e	65.67 d	73.00 f
T_9	17.33 a	29.67 a	46.33 a	23.33 f	25.00 e	14.67 g

In a column, figures having common letter (s) do not differ significantly at 5% level by DMRT.

The treatments were as follows:

1) T1 = Intercropping jute with of Amaranthus
2) T2 = Spraying with garlic extract (1: 100 dilution)
3) T3 = Spraying with neem extract (1: 100 dilution)
4) T4 = Spraying with 0.2% urea solution
5) T5 = Amaranthus + garlic extract
6) T6 = Amaranthus + Neem extract
7) T7 = Amaranthus + 0.2% solution
8) T8 = Roughing out of symptom bearing plant
9) T9 = Control

A

D

C

B

Plate: 1 (Legend, anticlock wise)

A. A general view of a corner of one of the experimental plots of the presented work at the plant pathology field laboratory, BAU agricultural farm.

B. A close-up view of above plot which shows plenty of typical symptom bearing plants at close proximity. The symptom bearing plants are clearly dwarfed compared to the healthy looking plants at the near.

C. Partially to completely (Left to right) yellowed symptom bearing leaves. Both chlorosis and leaf blade curling are typical symptoms.

D. Diseased leaves showing mosaic symptoms besides chlorosis and curl.

4.3 Effect of treatments on % diseased plant at different days after emergence (DAE)

The result of effect treatments on % diseased plant at different days after emergence is presented in table-3 and figure-2.

The percented diseased plant was significantly influenced by the treatments at different days after emergence (DAE).

At 30 DAE, the lowest (4.190) % disease plant was found under treatment intercropping with amaranthus plus spraying 0.2% urea solution (T_7).This was statistically similar to that of T5 (amaranthus with garlic extract) and T_6 (amaranthus with neem extract). On the other hand, T_9 (control) treatment was found with highest (56.99) % of disease plant.

At 60 DAE, the lowest (3.227) % disease plant was found in the same treatment (T_7). This was statistically similar to that of T_1 (intercropping of amaranthus), T2 (spraying with garlic extract), T_3 (spraying with garlic extract), T_4 (spraying with 0.2% urea solution), T_5 (amaranthus with garlic extract), T_6 (amaranthus with neem extract). On the other hand in the T_9 (control) treatment was found highest (59.07) % disease plant.

Again at 90 DAE, the lowest (5.403) % disease plant was found in the intercropping with amaranthus plus spraying 0.2% urea solution (T_7). On the other hand T_9 (control) treatment was found to have highest (61.63) % disease plant.

It was observed that some of the highly infected plants died and disappeared as withered quickly thus, sometimes can not be recorded. This phenomenon independent of % diseased plant when 60 DAE data are compared with the 30 DAE data. Some early symptoms themselves might have experienced recovery too.

Table 3. Effect of treatments on % diseased plant at different days after emergence (DAE)

Treatment	% Disease plant		
	30 DAE	60 DAE	90 DAE
T_1	5.407 c	4.237 c	22.88 b
T_2	5.193 cd	4.217 c	19.98 b
T_3	5.337 cd	3.987 c	16.08 c
T_4	4.673 de	3.987 c	13.82 cd
T_5	4.510 e	3.427 c	8.187 ef
T_6	4.387 e	3.903 c	10.89 de
T_7	4.190 e	3.227 c	5.403 f
T_8	52.73 b	8.977 b	11.81 de
T_9	56.99 a	59.07 a	61.63 a

In a column, figures having common letter (s) do not differ significantly at 5% level by DMRT.

The treatments were as follows:

1) T1 = Intercropping jute with of Amaranthus
2) T2 = Spraying with garlic extract (1: 100 dilution)
3) T3 = Spraying with neem extract (1: 100 dilution)
4) T4 = Spraying with 0.2% urea solution
5) T5 = Amaranthus + garlic extract
6) T6 = Amaranthus + Neem extract
7) T7 = Amaranthus + 0.2% solution
8) T8 = Roughing out of symptom bearing plant
9) T9 = Control

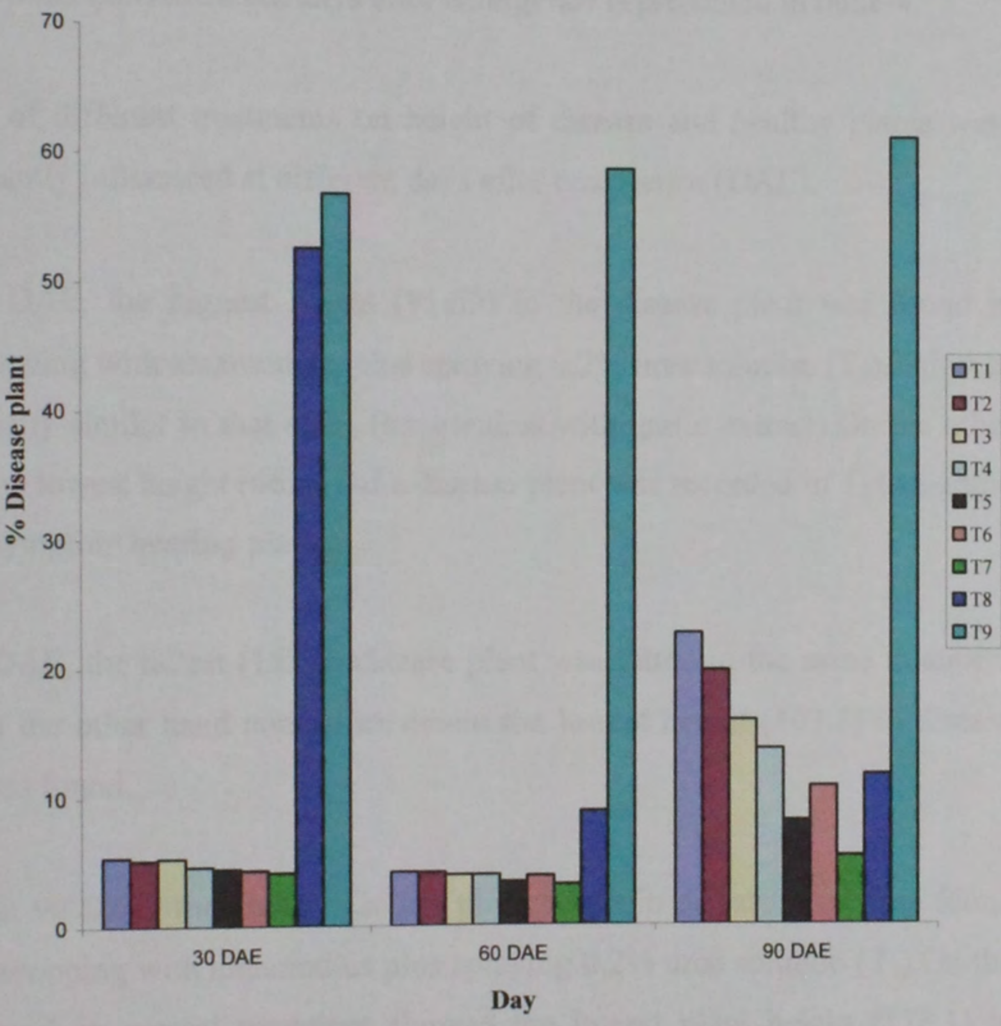


Fig 2: Effect of treatments on percent disease plant at different days after emergence (DAE)

4.4 Effect of treatments on height of diseased plant (cm) and height of healthy plant (cm) per plot at different days after emergence (DAE)

The result of effect treatments on height of disease plant (cm) and height of healthy plant (cm) different days after emergence is presented in table-4.

Effects of different treatments on height of disease and healthy plants were significantly influenced at different days after emergence (DAE).

At 30 DAE, the highest height (91.69) in the disease plant was found in intercropping with amaranthus plus spraying 0.2% urea solution (T_7).This was statistically similar to that of T_5 (amaranthus with garlic extract).On the other hand, the lowest height (66.46) of a disease plant was recorded in T_8 (roughing out of symptom bearing plant).

At 60 DAE, the tallest (153.4) disease plant was found in the same treatment (T_7).On the other hand control treatment the lowest height (103.8) in disease plant was found.

Again at 90 DAE, the highest (263.2) plant height in disease plant was found in intercropping with amaranthus plus spraying 0.2% urea solution (T_7).On the other hand in control treatment showed the lowest plant height (178.1) in disease plant was found.

At 30 DAE, the tallest (165.1) of healthy plant per plot was found intercropping with amaranthus plus spraying 0.2% urea solution (T_7). This was the statistically similar to that of T_5 (amaranthus with garlic extract).On the other Hand the lowest height (105.6) of healthy plant was found in treatment T_9 .

At 60 DAE, the tallest (255.9) of healthy plant per plot was found intercropping with amaranthus plus spraying 0.2% urea solution (T_7).On the other Hand the smallest (191.9) of healthy plant was found intreatment T_9 .

Again at 90 DAE the tallest (337.8) of healthy plant per plot was found in the treatment intercropping with amaranthus plus spraying 0.2% urea solution (T_7). On the other Hand the smallest (234.3) of healthy plant was found in control treatment.

Irrespective by treatment the diseased plants grew slowly due to the stunting effect of pathogenesis.

Table 4. Effect of treatments on height of diseased plant (cm) and height of healthy plant (cm) per plot at different days after emergence (DAE)

Treatment	Height of diseased plant (cm)			Height of healthy plant (cm)		
	30 DAE	60 DAE	90 DAE	30 DAE	60 DAE	90 DAE
T_1	84.64 c	149.2 bc	245.1 c	155.1 d	249.5 d	323.1 b
T_2	85.16 c	148.1 c	245.5 c	155.00 d	249.7 d	320.9 b
T_3	85.97 bc	149.3 bc	247.3 bc	158.4 cd	250.8 cd	321.1 b
T_4	86.73 bc	150.4 abc	252.8 bc	160.4 bc	251.9 bcd	322.3 b
T_5	91.09 a	151.7 ab	255.8 ab	165.2 a	254.5 ab	327.8 b
T_6	89.09 ab	150.1 abc	254.5 b	163.00 ab	253.4 abc	328.3 b
T_7	91.69 a	153.4 a	263.2 a	165.1 a	255.9 a	337.8 a
T_8	66.46 e	117.2 d	206.2 d	116.00 e	204.4 e	287.1 c
T_9	77.08 d	103.8 e	178.1 e	105.6 f	191.9 f	234.3 d

In a column, figures having common letter (s) do not differ significantly at 5% level by DMRT.

The treatments were as follows:

1) T1 = Intercropping jute with of Amaranthus
2) T2 = Spraying with garlic extract (1: 100 dilution)
3) T3 = Spraying with neem extract (1: 100 dilution)
4) T4 = Spraying with 0.2% urea solution
5) T5 = Amaranthus + garlic extract
6) T6 = Amaranthus + Neem extract
7) T7 = Amaranthus + 0.2% solution
8) T8 = Roughing out of symptom bearing plant
9) T9 = Control

4.5 Effect of treatments on base diameter of disease plant (mm) and base diameter of healthy plant (mm) at different days after emergence (DAE)

The result of effect treatments on base diameter of disease plant (mm) and base diameter of healthy plant (mm) at different days after emergence is presented in table-5.

At 30 DAE, the highest (6.707) base diameter in disease plant was found in the treatment who got spraying with garlic extract (T_2).This was statistically similar to that of T_1 (intercropping of amaranthus); T_3 (spraying with neem extract); T_4(spraying with 0.2% urea solution);T_5 (amaranthus with garlic exyract);T_6 (amaranthus with neem extract) and T_7 (amaranthus with 0.2% urea solution). On the other hand, the lowest (4.510) base diameter in disease plant was recorded in the T_9.This was statistically similar to that of T_8 (roughing out of symptom bearing plant).

At 60 DAE, the highest (12.21) base diameter of disease plant was found in amaranthus with garlic extract (T_5).This was statistically similar to that of T_7 (amaranthus with 0.2% urea solution). On the other hand T_9 (control) treatment was found to have smallest (7.520) base diameter in disease plant. This was statistically similar to that of T_8 (roughing out of symptom bearing plant).

Again at 90 DAE, the highest (19.72) base diameter in disease plant was found in the treatment with intercropping with amaranthus plus spraying 0.2% urea solution (T_7).On the other hand T_9 (control) treatment was found to have the smallest (11.57) base diameter in disease plant.

At 30 DAE, the highest (12.34) base diameter of healthy plant per plot was found in treatment intercropping with amaranthus plus spraying 0.2% urea solution (T_7).This was the statistically similar to that of T_5 (amaranthus with garlic extract).On the other hand the lowest (7.317) base diameter of healthy plant was found in the treatment T_8 (roughing out of symptom bearing plant).

At 60 DAE, the highest (17.93) base diameter of healthy plant per plot was found under the treatment intercropping with amaranthus plus spraying 0.2% urea solution (T_7). This was statistically similar to that of T_5 (amaranthus with garlic extract). On the other hand the lowest (11.86) base diameter of healthy plant was found in t reatment T_9. Again at 90 DAE the highest (24.68) base diameter of healthy plant per plot was found in the treatment intercropping with amaranthus plus spraying 0.2% urea solution (T_7). On the other hand the lowest (17.70) base diameter of healthy plant was found in treatment T_9 .

Table 5. Effect of treatments on base diameter of disease plant (mm) and base diameter of healthy plant (mm) at different days after emergence (DAE)

Treatment	Diameter of infected plant (mm)			Diameter of healthy plant (mm)		
	30 DAE	60 DAE	90 DAE	30 DAE	60 DAE	90 DAE
T_1	7.343 a	10.15 bc	15.44 de	9.527 b	13.90 cde	20.37 cd
T_2	6.707 a	9.637 c	16.52 cd	9.147 bc	14.69 bcd	21.80 abc
T_3	7.633 a	10.60 abc	13.81 ef	9.657 b	15.94 abc	20.55 bcd
T_4	8.00 a	10.76 abc	15.38 de	9.637 b	16.13 ab	19.53 cd
T_5	7.677 a	12.21 a	18.55 ab	11.52 a	17.04 a	23.70 ab
T_6	7.307 a	11.87 ab	17.73 bc	9.937 b	16.80 ab	21.88 abc
T_7	7.983 a	12.48 a	19.72 a	12.34 a	17.93 a	24.68 a
T_8	4.853 b	7.523 d	12.56 fg	7.317 d	13.46 de	18.77 cd
T_9	4.510 b	7.520 d	11.57 g	8.167 cd	11.86 e	17.70 d

In a column, figures having common letter (s) do not differ significantly at 5% level by DMRT.

The treatments were as follows:

1) T1 = Intercropping jute with of Amaranthus
2) T2 = Spraying with garlic extract (1: 100 dilution)
3) T3 = Spraying with neem extract (1: 100 dilution)
4) T4 = Spraying with 0.2% urea solution
5) T5 = Amaranthus + garlic extract
6) T6 = Amaranthus + Neem extract
7) T7 = Amaranthus + 0.2% solution
8) T8 = Roughing out of symptom bearing plant
9) T9 = Control

A

D

B

C

Plate: 2 (Legend, anticlock wise)

A. A healthy jute plant collected at the time of harvest.

B. A leaf yellow mosaic infected plant harvested at the same time. The plant leaves all mosaiced leaves and dwarfing symptoms.

C. Jute fibre from an infected plant: less weight and volume, discoloured weak fibre.

D. Jute fibre from a healthy plant: longer, higher, in volume and weight, beautiful fibre texture, general golden-white colour.

4.6 Performance of treatments on fibre weight and sticks weight (yield components) of jute against jute yellow mosaic infection.

The result of different treatments on fibre weight and sticks weight (yield components) of jute plant are presented in table-6 and figure-3 and 4.

Effects of different treatments on fibre weight and sticks weight (yield components) of jute against jute yellow mosaic infection. The highest fibre weight (13.57) of infected plants was measured as in the treatment including intercropping with amaranthus plus spraying 0.2% urea solution (T_7).The next best fibre weight (12.66) was found as in T_5 (amranthus with garlic extract).This was statistically similar to that of T_1, T_2, T_3 and T_4. The lowest fibre weight (10.01) which was closely related to T_9 (control).This was statistically similar to that of T_8 (roughing out of symptom bearing plant).The highest fibre weight (20.93) in healthy plant was found as T_7 (amranthus with spraying 0.2% urea solution).The lowest fibre weight (12.30) per plant of healthy plant was measured in T_9 (control).

The highest stick weight (20.97) of infected plants was found as in T_7 (amaranthus with 0.2% urea solution).The lowest stick weight (15.61) was recorded as in infected plant of T9 (control). The highest stick weight (41.32) in healthy plant was measured in T_7 (amaranthus with 0.2% urea solution).The lowest stick weight (23.51) was obtained in T_9 (control).

Table 6. Performance of treatments on fibre weight and sticks weight (yield components) of jute against jute yellow mosaic infection.

Treatment	Fibre weight of infected plant (g/plant)	Fibre weight of healthy plant (g/plant)	Stick weight of infected plant (g/plant)	Stick weight of healthy plant (g/plant)
T_1	12.52 ab	15.80 de	17.77 bc	37.67 c
T_2	11.72 ab	17.09 cd	18.29 b	37.88 bc
T_3	11.61 ab	18.35 bd	17.50 bc	39.15 abc
T_4	10.90 ab	18.22 bc	17.06 bcd	39.26 abc
T_5	12.66 ab	19.55 ab	18.73 b	40.29 ab
T_6	12.59 ab	19.10 abc	18.15 b	39.70 abc
T_7	13.57 a	20.93 a	20.97 a	41.32 a
T_8	10.22 b	14.03 ef	15.94 cd	34.87 d
T_9	10.01 b	12.30 f	15.61 d	23.51 e

In a column, figures having common letter (s) do not differ significantly at 5% level by DMRT.

The treatments were as follows:

1) T1 = Intercropping jute with of Amaranthus
2) T2 = Spraying with garlic extract (1: 100 dilution)
3) T3 = Spraying with neem extract (1: 100 dilution)
4) T4 = Spraying with 0.2% urea solution
5) T5 = Amaranthus + garlic extract
6) T6 = Amaranthus + Neem extract
7) T7 = Amaranthus + 0.2% solution
8) T8 = Roughing out of symptom bearing plant
9) T9 = Control

A B

Plate: 3

A photograph showing jute sticks of:

A. Healthy jute plant: Taller, greater stick diameter, thus with higher length and greater weight.

B. A jute stick obtained from a jute yellow mosaic symptom bearing plant: having stick of much inferior quality.

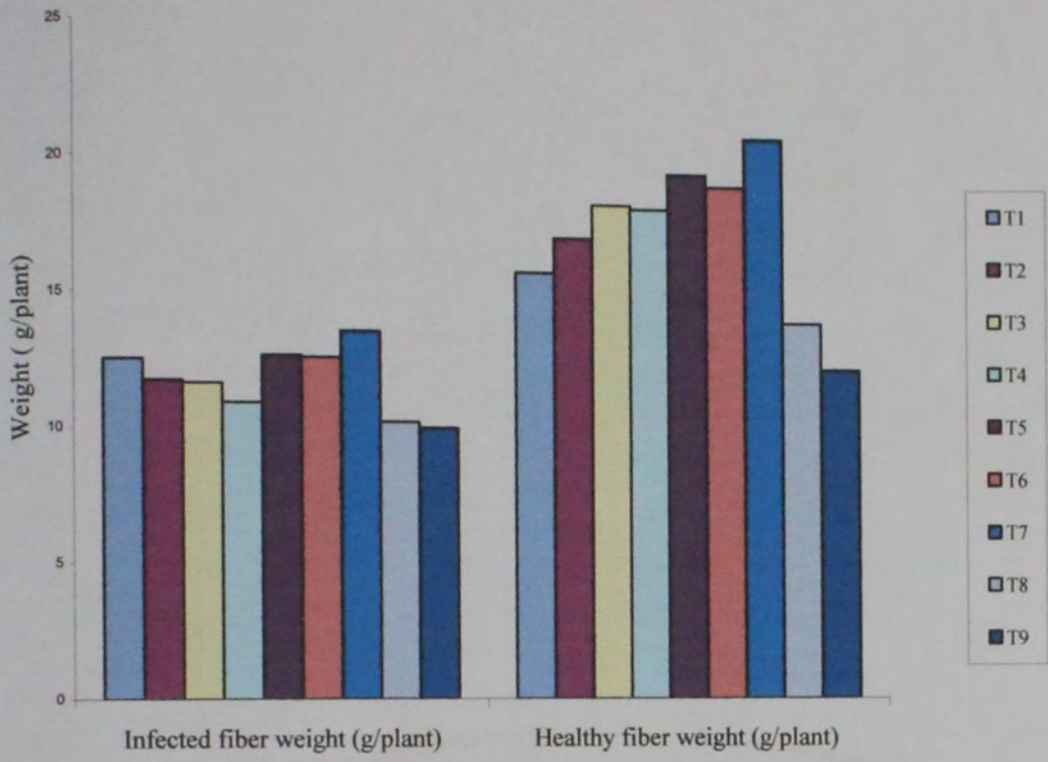


Fig 3: Performance of treatments on fiber weight (infected and healthy plant) of jute against jute yellow mosaic infection.

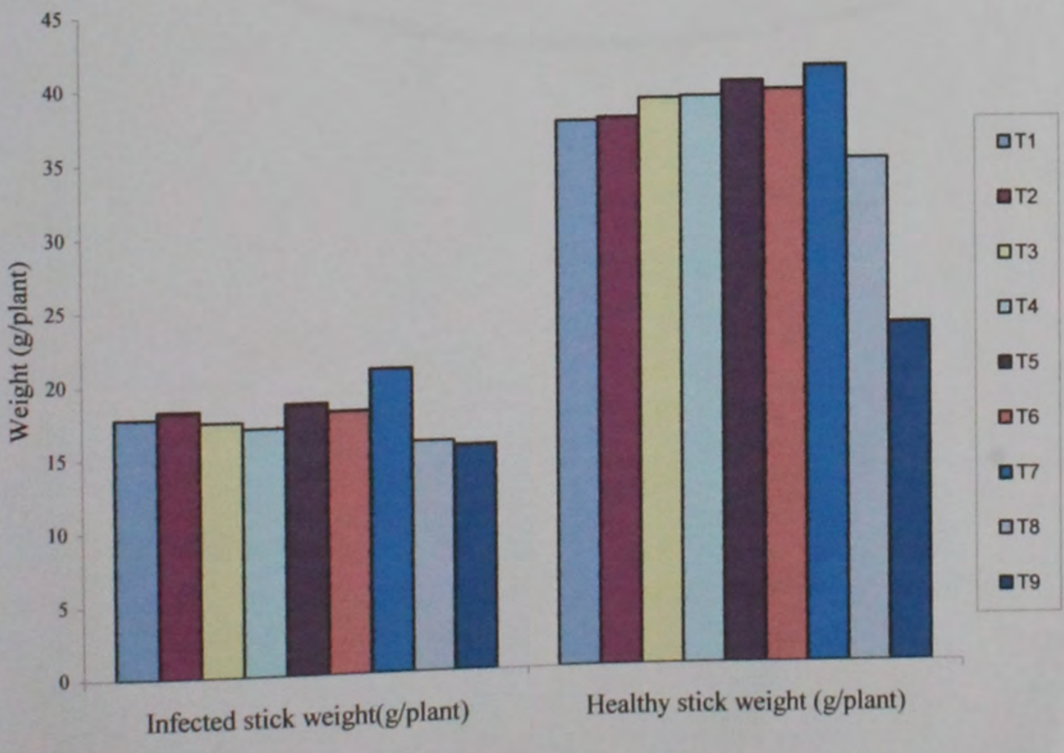


Fig 4: Performance of treatments on stick weight (infected and healthy plant) of jute against jute yellow mosaic infection.

DISCUSSION

Investigations were carried out to find out the performance of integrated management practices against jute yellow mosaic disease. The management practices employed influenced to increase yield components, yield, and quality of fibre. Percent yellow mosaic disease of jute was recorded in different growth periods (30, 60 and 90 DAE) of seedling. The diseased plants were located on the basis of symptoms.

Effect of treatments on the number of infected plant and healthy plant per plot was found to be significantly influence by different treatments. At 30 DAE, the treatment intercropping with amaranthus and 0.2% foliar spray of urea solution (T_7) showed highly significant performance in reducing the infected plant. This was however similar to that of intercropping with amaranthus and neem extract as a foliar spray (T_6). The second highly significant performance in lowest number of infected plant was observed in intercropping with amaranthus and garlic extract (T_5).On the other hand treatment control (T_9) showed highest number of infected plant. But the highest number healthy plant per plot was found in intercropping with amaranthus and foliar spray with 0.2% urea solution (T_7). The second highly significant performance in highest number of healthy plant per plot was observed in T_1, T_2, T_3, T_4 and T_6. The lowest number of healthy plant per plot was found in control (T_9).

At 60 DAE, the lowest number of infected plant per plot was found in T_7 treatment which was statistically similar to that of T_5 treatment. The next performance was obtained by the treatment intercropping with amaranths (T_1), spraying with garlic extract (T_2) and roughing out of symptom bearing plant (T_8).The highest infected plant per plot was observed in control (T_9). But the highest no. of healthy plant per plot was found in T_7 (intercropping with amaranthus and 0.2% urea solution. This was statistically similar to that of T_5 (intercropping with amaranthus and garlic extract).

The next performance was obtained by the treatment intercropping with amaranthus and neem extract (T_6). The lowest number of healthy plant per plot was found in control (T_9). At 90 DAE, the lowest no. of infected plant per plot was observed in T_7 treatment. The next performance was found by the treatment roughing out of symptom bearing plant (T_8).The highest number of infected plant per plot was observed T_9 (control). But the highest number of healthy plant was found in intercropping with amaranthus and 0.2% urea solution (T_7). The lowest no. healthy plant per plot was observed T_9 (control). The experiment in no. of infected plant and healthy plant were influence more or less significantly all the different treatments.

In all the parameter considered in this research. At 60 DAE and 90 DAE the relative performances of treatment on the healthy and diseased jute plants were similar as at 30 DAE, the figures only were changed due to time and disease progress.

In nutshell, jute yellow mosaic disease in *Corchorus oltorius* has been found to be influenced by treatments. The treatment T_7 which included growing of jute intercropped with Amaranthus and receiving foliar spray with 0.2% urea solution had the largest number of healthy plants/plots where the healthy plants were the tallest among the tall plants; even the few diseased plants. This group had best height, lowest diseased leaves per plant; best base diameter and therefore the best fibre and stick production. The quality of stick and fibre also better then any under the T_7 treatment.

The reason for this scenario obvious as this combined treatment supplied the standing plant extract 0.2% urea as foliar spray. The other combined treatments performed best than other treatments and of course the control.

Jute is coming up grain. There is a high possibility that the golden fibre of Bengal will not only region its lost glory but also with greater claim ever in the world market because the people do not want to use synthetic fibre for those products are not eco-friendly. So for certain products people must turn to jute. Therefore jute products will need better and eco-friendly care.

The results of this experiment, though was not strictly about organic product; on of healthy jute crop, the integration components about under test here are eco-friendly as they are water suspension of crude extracts of very easily available plants. Fortunately all of these have shown significant potency or efficiency. A judicial selection of the components integration and application gives a good promise for healthy production of high quality jute.

Quest for other such options and important of cultural practices and even post harvest practices should improve the production and profit of the farmers.

SUMMARY AND CONCLUSION

An experiment was conducted in the field condition to find out the performance of eight integrated management practices with an objective to find their potential to minimize jute yellow mosaic incidence and to contribute to quality improvement and yield of jute compared to a control treatment.

The selected integrated management practices were employed in the field randomly in RCBD design having three replications. Altogether there were nine treatments viz. T_1= Intercropping with amaranthus, T_2= Spraying foliar with garlic extract (1: 100 dilutions), T_3= Spraying foliar with neem extract (1:100 dilutions), T_4= Spraying foliar with 0.2% urea solution, T_5= Intercropping with amraranthus and spray with garlic extract, T_6= Intercropping with amaranthus and spray with neem extract, $T_{7=}$ Intercropping with amaranthus plus spray with 0.2% urea solution, T_8= Roughing out of symptom bearing plant and T_9= Control (Non treatment). At 30, 60 and 90 days after emergence (DAE) of seedling data was collected on different treatment compared to the control treatment (T_9), all the treatments (T_1, T_2, T_3, T_4, T_5, T_6, T_7, and T_8) contributed to the reduction of yellow mosaic disease incidence in the plots more or less equally significantly.

The highest percent of jute yellow mosaic incidence was found naturally in (T_9) plots had the lowest disease incidence among the eight treatments under T_7.

The data on yield and yield components had been taken after harvest of mature jute plants. The analyzed result showed significant variations in the average effect on yield components and yield under different treatments. Intercropping with amaranthus plus a foliar spray with 0.2% urea solution (T_7), intercropping with amaranthus and foliar spray with 1:100 dilution of garlic extract (T_5), intercropping with amaranthus and foliar spray with 1:100 dilution neem extract (T_6) performed the best.

In conclusion it can be said that, among the different integrated management practices, employed in the present research work, in order of preference according to the findings are (I) intercropping with amaranthus and application of 0.2% urea solution as foliar spray (ii) intercropping with amaranthus and spraying 1:100 dilution garlic extract and (iii) intercropping with amaranthus and as foliar spray with neem extract. Spraying with 0.2% urea solution, spraying with neem extract, spraying with garlic extract and roughing out of symptom bearing plant also seemed to have a positive contribution. A judicious combination of the 0.2% urea components may contribute to minimize jute yellow mosaic disease in the field and can promote higher production of good quality fibre and jute stick. Thus combination of different integrated management practices may assist to build up a model of Integrated Disease Management (IDM) protocol to ensure healthy and profitable jute crop may be expected.

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