Effect of Intercropping Rice with Maize and Soybeans on Disease Incidence, Severity and Yield of Rice in Abia State

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Abstract: - The experiment was conducted in 2010 and 2011 planting seasons in an upland location. The experiment involved the planting of faro 48 which was most susceptible to the common fungal diseases as revealed by the seed health test done in earlier experiment. One variety of maize (Oba Super 2), hybrid maize and one variety of soybeans commonly planted in the area TGX 1448260 were used. Three treatments of Rice + Maize, Rice + Soybeans and Sole Rice as control were used in the experiment. The experiment was laid out in randomized complete block design (RCBD) and replicated 12 times. Effective planting area of each block was 6m x 2m, giving $12m^2$ while each plot in a block was measured 2m x 2m, giving $4m^2$. A total area of the farm with the paths was 12m x 4m which equals $48m^2$. The experiment was sited at the eastern farm of Michael Okpara University of Agriculture, Umudike and research farm of National Cereal Research Institute, Amakama Umuahia South LGA. The land was ploughed and harrowed and later ridges were made. The ridges were converted into bed measuring 2m x 2m with 50cm path between each and 1m path between each block. The rice was planted four seeds per stand at a distance of 20cm x 20cm. This gave a plant population of 250,000 stands per hectare. Soybean and maize were planted at the distances of 25cm x 50cm and 25cm x 75cm respectively in between the rows of rice plants in a staggering arrangement. The plant population for soybean was 80,000 stands / ha while maize had 53,333 stands / ha. Relevant data collected from the rice crop include: Plant height, number of tillers, leaf area, root length, panicle length, one thousand seed weight, and yield per plot and disease assessment. Data collected were subjected to ANOVA in RCBD using GenStat software. The results showed that there was a significant effect of intercropping on the yield of rice. The highest yield (290.07g) was obtained in rice + soybean mixture. This was significantly higher than the other mixtures, followed by (235.13g) obtained in rice only. This was significantly the same as the least (220.44g) obtained in rice + maize mixture .There was a significant effect of intercropping on disease incidence on rice plants. The highest disease incidence of (64.10%) obtained in rice + soybean which is significantly higher than (50.90%) obtained in rice + rice but not different from (37.20%) obtained in rice only in Umudike. There was a significant effect of intercropping on disease severity on rice plants, where the highest disease severity of 3.25 occurred in rice + soybean mixture. This was significantly higher than the least disease severity value (1.92) obtained in rice only as well as 2.00 obtained in rice + maize. It is therefore recommended that rice and some complementary crops such as soybean be intercropped to increase yield in order to maximize profit.

Key-Words: - Intercropping, disease incidence, severity, rice, maize, soybean, yield.

1 Introduction

Intercropping is the growing of two or more crops simultaneously in the same field [1]. Many crops arc intercropped with upland rice depending on the length of growing period and farmer preference. The common systems include:

rice + maize, rice + maize + cassava, rice + cowpea, rice + sesame, rice + beniseed, rice + soybean, rice + mungbean, rice + pigeon pea, rice +

sugarcane, rice + capsicum etc [1]. Intercropping increases productivity of complementary, component crops. Well designed intercropping combines component crops that use resources more fully than would single crops [1]. Intercropping is the predominant cropping system in traditional and some extent modern Agriculture [2]. Intercropping increases productivity through maximum utilization of land, labour and capital resources and management of insect pests and disease as reported by [3].

Though the problems of pests and diseases could be handled through the use of synthetic and non-synthetic pesticides [4, 5, and 6] or through the use of biological agent [7], as well as the use of resistant varieties. The success achievable by these methods are not without attendant problems associated with their uses. These problems include high cost of control, pest resistance and resurgence as well as adverse environmental impact associated with their use. These and other problems associated with the use of chemical control approach have made intercropping system which is environmentally safe and less costly a better alternative.

Intercropping when used either singly or in combination with other compatible methods could be employed in a sustainable manner to alleviate some of these problems in crop production and increase yield. Intercropping rice with soybean helps to increase productivity because soybean fixes nitrogen into the soil which is an important nutrient required by rice [1]. [8]. concluded that intercropping soybean and maize on flat result in optimum yield and that the maximum combined intercrop revenue from maize and soybean was from inter + intra-row planting arrangement on flat.

2 Materials and Methods

The experiment was conducted in 2010 and 2011 planting seasons in an upland location. The experiment involved the planting of faro 48 which was most susceptible to the common fungal diseases as revealed by the seed health test done earlier in experiment three. One variety of maize (Oba Super 2), hybrid maize and one variety of soybeans commonly planted in the area TGX 1448260 were used. Three treatments of Rice + Maize, Rice + Soybeans and Sole Rice as control were used in the experiment. The experiment was laid out in randomized complete block design (RCBD) and replicated 12 times

Effective planting area of each block was 6m x 2m, giving $12m^2$ while each plot in a block was measured 2m x 2m, giving $4m^2$. A total area of the farm with the paths was 12m x 4m which equals $48m^2$.

2.1 Land Preparation

The experiment was sited at the eastern farm of Michael Okpara University of Agriculture, Umudike and research farm of National Cereal Research Institute, Amakama Umuahia South LGA. The land was ploughed and harrowed and later ridges were made. The ridges were converted into bed measuring 2m x 2m with 50cm path between each and 1m path between each block.

The rice was planted four seeds per stand at a distance of 20cm x 20cm. This gave a plant population of 250,000 stands per hectare. Soybean and maize were planted at the distances of 25cm x 50cm and 25cm x 75cm respectively in between the rows of rice plants in a staggering arrangement. The plant population for soybean was 80,000 stands / ha while maize had 53,333 stands / ha.

The experimental farm was cleared and ploughed, harrowed, ridged mechanically.

All normal agronomic practices of weeding and fertilizer application were carried out.

Weeding was done manually with the use of hoe/land pilling. The weeding was done at four weeks after planting. Fertilizer application was done at the rate of 75 – 30 – 30kg at 200kg/ha using NPK 15:15:15 five weeks after planting and later 200kg/ha of urea at 46:0:0 three months after planting before panicle initiation. Hand pulling of weeds and clearing of the edges of the experimental farm were done as the need arose. The whole plot was fenced round with nylon netting to prevent rodents such as the bush rat, grass cutter, bush fowl. Though bush fowl was one of the major threats especially during first few days after planting of maize and rice. Scarecrows were also mounted to reduce the menace of these pests. Relevant data collected from the rice crop include: Plant height, number of tillers, leaf area, root length, panicle length, one thousand seed weight and yield per plot.

For leaf area, length x width method was used. All other linear measurements were done with meter-rule. Just before harvest, plant height was measured on only selected rice plants. This was measured by taking the distance from the soil surface to the top of the tallest stem measured at the ring of hairs below the panicle junction of culm and peduncle

Panicle length was measured from ring of hairs at the junction of the panicle and culm to the tip of the most distal grain awns. At maturity the central rows within 2m x 2m were harvested, threshed and carefully, winnowed and weight of the grains was recorded. The yield was expressed in tones/ha.
Disease assessment was done at panicle shooting and ripening for rice plants.

A five point scoring method as suggested by [9] for subjective evaluation was used. The scoring scale is as follows

1 = 1 – 20% plants infected
2 = 21 – 39% of plants infected
3 = 40 50 of plants infected
4 = 51 – 69% of plants infected
5 > 70% of plants infected

The percentage disease incidence was also determined by using the formula

$$\frac{\text{Number of diseased plants}}{\text{Total number of plants sampled}} \times \frac{100}{1}$$

2.2 Inoculation of the Rice Plants in the Field with *Fusarium monliforme*

The rice plants were inoculated with the test fungi pathogen – *Fusarium moniliforme* spores. The concentration of the spores in distilled sterile water was 10^6 dispersed in Tween – 8 solutions.

The spores were applied by spraying method using hand sprayer. The two middle rows of the rice plants in each plot were inoculated with the spores. The control was sprayed with only distilled sterile water. The spraying was done when the wind was very stable. This was to ensure that the non-target plants were not also contaminated with the sprays. Data collected were subjected to ANOVA in RCBD using GenStat software.

3 Results

3.1 Effect of the Intercropping Rice with Soya Bean and Maize on the Growth, Yield, Incidence and Severity of Rice Seed Rot caused by *Fusarium moniliforme* in Umudike and Amakama

The results in Table 1 shows that there were significant effects of intercropping on the parameters studied. There was a significant effect of intercropping on plant height of rice in Umudike. The Highest plant height (86.70cm) occurred when rice was intercropped with soybean. This was significantly higher than rice and maize intercrop with the least plant height (72.60cm) but same statistically with (79.50cm) obtained in rice only (Table 1). There was a significant effect of intercropping on number of rice tillers.

Table 1: Effect of intercropping rice with maize and soybean on growth, yield, incidence and severity of rice seed rot caused by *Fusarium moniliforme* in Umudike and Amakama.

Growth parameters, disease incidence (%) and severity

Treatment&locations	PH(cm)	T	RL(cm)	PL(cm)	LA(cm^2)	SW(g)	YD(g)	YD(t/ha)	DI (%)	DSV
Umudike										
Rice only	79.5	11.08	9.50	23.42	82.80	23.67	201.00	0.50	37.20	2.00
Rice + Soybean	86.7	13.17	11.42	23.50	95.00	24.58	226.50	0.56	64.10	3.25
Rice + maize	72.6	10.00	10.25	23.75	75.80	23.75	196.9	0.49	50.9	1.92
LDS 0.05	9.85	NS	2.09	NS	9.96	0.69	15..26	0.04	6.63	0.67
Amakama										
Rice only	73.17	15.67	14.00	21.92	74.67	24.83	235.15	0.59	19.17	1.75
Rice + Soybean	84.25	17.00	18.42	24.17	90.25	25.29	290.07	0.73	24.83	2.08
Rice + maize	64.58	7.33	9.92	20.92	69.75	24.11	220.11	0.55	30.00	2.67
LDS 0.05	5.82	8.88	3.49	1.17	6.26	NS	49.00	0,07	6.67	0.61

PH = Plant height
T = Tillers
RL = Root Length
PL = Panicle Length
LA = Leaf Area
SW = Seed Weight
DI = Disease Incidence (%)
DSV = Disease Severity
YD = Yield/ha

The highest tiller number (13.17) occurred in rice + soybean mixture which was not significantly different from number of tillers obtained in rice only (11.08) and rice + maize intercrop. Table 1 showed that there was no significant effect of intercropping on root length of rice, even though the highest root length (11.42cm) was obtained in rice + soybean mixture followed by rice + maize mixture (10.25cm) while the least was obtained in rice (9.50cm) only. The same trend was repeated on effect of intercropping on panicle length of rice plants. Though the highest panicle length (23.75cm) occurred in rice + maize intercrop followed by rice + soybean mixture (23.50cm), while the least (23.42cm) occurred in rice only.

Intercropping had a significant effect of on leaf area of rice. The largest leaf area occurred in rice + soybean intercrop (95.00cm2). This was significantly different from that obtained in rice + maize mixture (75.80cm2) but statistically same when rice was planted alone (82.80cm2). The least leaf area was recorded in rice + maize intercrop (75.80cm2) (Table 1). There was a significant effect of intercropping on seed weight of rice. The highest seed weight (24.58g) was obtained in rice + soybean intercrop which was significantly higher than rice + maize intercrop (23.75g), while the least occurred in rice only (23.67g) (Table 1).

There was a significant effect of intercropping on rice yield and the highest yield was obtained in rice + soybean intercrop (226.50g), followed by rice only (201.00g) whereas the least weight was obtained in rice + maize mixture (196.90g). The yield of 226.50g in rice + soybean mixture was significantly different from 196.90g observed in rice +maize intercrop but statistically same as 201.00g recorded in rice only.

Intercropping had a high significant effect on incidence of disease on rice plants. The highest disease incidence was obtained in rice + soybean mixture (64.10%) which is statistically different from other intercrops. This was followed by 50.90% obtained in rice + maize mixture which differed significantly from the least disease incidence of 37.20% which occurred in rice only in Umudike (Table1).

There was a significant effect by intercropping on disease severity of rice, where the highest disease severity (3.25) was obtained in rice + soybean followed by that obtained in rice only (2.00) while the least value 1.92 occurred in rice + maize. Disease severity of (3.25) obtained in rice + soybean was significantly higher than those obtained in either rice + maize or rice only.

In Amakama intercropping had a significant effect on all the parameters considered except seed weight (Table1). There was a high significant effect of intercropping on plant height where the largest plant height for rice was obtained in Rice + soybean intercrop (84.25cm) which was significantly higher than the rest intercropping systems. This was followed by rice only (73.17cm whereas the least was rice + maize only (64.58cm) (Table1). Intercropping had a significant effect on number of tillers of rice. The highest tiller number was obtained in rice + soybean (17.00), which differ from rice + maize intercrop (7.33) whereas the second largest tiller number was in rice only (15.67). This is statistically the same with the least tiller in rice + maize (7.33) (Table1).

Intercropping also had a high significant effect on the root length of rice. The highest root length was recorded in rice + soybean mixture (18.42cm) which was significantly higher than the rest mixtures followed by rice only (14.00cm). This also differs from (9.92cm) being the least which occurred in rice + maie mixture.

There was a significant effect of intercropping on the panicle length of rice. The highest panicle length) was obtained in rice + soybean intercrop (24.17cm which is significant higher than the other mixtures. This was followed by rice only (21.92cm). This was not significantly different from rice + maize mixture (20.92cm) (Table 1).

There was a high significant effect of intercropping on the leaf area of rice. The largest leaf area was obtained in rice + soybean mixture (90.25cm2) which was significantly higher than both rice + maize and rice only. Rice only (74.67cm2) was statistically the same with rice + maize mixture (69.75cm2) (Table1).

Intercropping had no significant effect of on seed weight of rice. The largest seed weight was obtained in rice + soybean intercrop (25.29g), which was followed by rice only (24.83g) whereas the least was obtained in rice + maize mixture (24.11g).

There was a significant effect of intercropping on the yield of rice. The highest yield was recorded in rice + soybean mixture (290.07g). This was significantly higher than the other mixtures, followed by rice only (235.13g) which was significantly the same with the least recorded in rice + maize mixture (220.44g) (Table1).

There was a significant effect of intercropping on disease incidence on rice plants. The highest disease incidence was obtained in rice + maize (30.00%) which was significantly higher than value recorded in rice only (19.17%) but not significantly different

from that obtained in rice + soybean (24.83%) (Table1).

There was a significant effect of intercropping on disease severity on rice. The highest disease severity was recorded in rice + soybean mixture (3.25). This was significantly higher than the least disease severity value (1.92) obtained in rice only as well as 2.00 obtained in rice + maize (Table 1) in Umudike.

4 Discussion

4.1 Effect of Intercropping Rice with Soybean and Maize on Yield and Yield Components of Rice Plants in Abia State.

The result of the two consecutive seasons of planting (2010 and 2011) showed that there was a significant effect of intercropping on rice yield. The yield of rice in rice + soybean intercrop was (226.50g) in 2011 and (290.07g) in 2011 respectively which were significantly higher than (201.00g) obtained in rice only in 2010 and the least was (196.90g) in rice + maize. The same trend was repeated in 2011 where rice only (235.13g) had the second largest yield while the least (220.44g) was obtained in rice + maize mixture. This result is in agreement with [10]. who reported in their experiment where rice was intercropped with Mumgbean, soybean, peanut, ricebean and blackgram observed that rice + mungbean, rice + soybean, rice + peanut and rice + blackgram intercrop mixtures gave higher than rice + ricebean. They also observed that rice + rice bean and rice + blackgram gave yield higher than the rest when deferred planting was practiced. Also they observed that all intercropping treatments of rice + legume save rice + ricebean (planted simultaneously) were greater in land equivalent ratio (LER) Relative net return (RNR) and Money advantage MA. Their result also showed that competitive ratio (CR) of rice was one in deferred planting except rice + blackgram and rice + Mungbean in the first year but only in rice + blackgram the second year. The result showed that rice + soybean mixture gave the highest yield for the two consecutive years (226.50g) and (290.07g) respectively which was significantly higher than the rest. This could have been as a result of nutrients balance relationship that existed between rice a cereal crop) a high nitrogen – dependent crop) which was complemented by the supply of nitrogen by legume crop (soybean). That might have resulted to adequate growth and development of the rice crop which eventually resulted to higher yield compared to other intercrop mixtures that hadn't nitrogen fixing crop to replenish the heavy – draw of the element by the two cereal crops. This is in disagreement with the report of [11], who observed that there was a yield reduction of rice as a result rice + legume intercrop. They reported that the legume crop such as sesbania caused the maximum rice grain yield reduction due to the luxuriant growth of sesbania and shading effect on the associated rice which ultimately resulted in poor and low yield of the rice crop. The same views were also reported by [12].

The result also showed that there was a significant effect of intercropping on some yield components of rice in the two consecutive years. For most of the yield components such as plant height, Tiller number, leaf area, 1000 – seed weight, rice + soybean mixture consistently produced the highest values which were significantly different from the other two intercrop mixtures. This could have been as a result of nutrient balance that existed between the cereal (high nitrogen dependent crop) and soybean, which replenished the nitrogen taken up by rice crop thereby ensuring proper growth and development which cumulated to higher yield.

This result was in disagreement with reports of [13]. who found that intercropping rice with grain legume resulted in the reduction in plant height, number of panicle bearing tiller per m^2, number of grain per panicle, grain weight per panicle, 1000 grain weight and rice grain yield. They were of the opinion that the luxuriant growth habit of most of the legume crops coupled with the thick shading effect on the associated rice crop ultimately resulted in poor growth and low yield of the rice crop. This view was also reported by [12].

The results obtained in this study were in consonance with the reports of [14]; [15] who observed that the mixture of nitrogen fixing crop and non-fixing crop gave greater productivity than monocropping. [16] reported that cereal – legume intercropping system were superior to monocropping.

[17] also reported, that by intercropping, land was effectively utilized and yield was improved. The crops are grown together because of higher yield and greater biological and economic stability in the system [18]. When two crops are grown together, yield advantage occurs because of differences in their use of resources [29]. Also land equivalent ratio (LER) is higher under intercropping [20].; [21].

5 Conclusion

Intercropping being an integral system of traditional Agriculture which serves the bulk of Agricultural productivity in Nigeria, should be encouraged especially when it is aimed at minimizing the effect of pests and diseases rather than the use of chemical control methods.

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