Stem Borer Damage and Rice Yield as Influenced by Transplanting date and N-Fertilization

[1]Ogah, E. O., [2]Echezona, B. C. and [1]Mbah, M. C.
[1]Department of Crop Production Technology, Ebonyi State University, Abakaliki, Ebonyi State, Nigeria
[2]Department of Crop Science, University of Nigeria, Nsukka, Nigeria

Corresponding Author: Echezona, B. C., Department of Crop Science, University of Nigeria, Nsukka, Nigeria.

Abstract

In order to obtain appropriate information on cultural practices to control the stem borer damage, an investigation on the influence of three transplanting dates: July 31, August 14 and August 28, 2003 and three rates of Nitrogen : 0 kg ha^{-1}, 80 kg ha^{-1} and 160 kg N ha^{-1} supplied as urea N-fertilizer on stem borer damage was carried out. The field was laid in a split-plot in a randomized complete block design (RCBD) with three replications. While transplanting dates were assigned to the main-plots, nitrogen rates were assigned to the sub plots. The results show that incremental rates of nitrogen significantly increased damage incidences ('Dead heart' and 'White heads') on rice by stem borers (P = 0.05). N-fertilization at 80 kg N ha^{-1} significantly produced the highest grain yield (P = 0.05). Delay in transplanting date significantly and progressively increased damage incidences by the stem borers (P = 0.05). The optimum harvest was achieved when rice was transplanted on August 14, 2003. Similarly, differences in the interaction treatments between transplanting dates and N-fertilization were significant (P = 0.05). This was such that rice transplanted on August 14, 2003 and treated with 80 kg ha^{-1} produced the greatest grain yield and showed a good promise for stem borer damage control.

Key Words: Rice, Stem borer, Transplanting dates, N-fertilizer

Introduction

The ecology of Nigeria is suited for the cultivation of rice. Nigeria has about 73.7 million hectares of arable land and the area under rice cultivation has increased tremendously in the last few decades. Of this available area, 60% is devoted to rain fed upland rice, 5% to irrigated rice and the rest is under swamp and fadamas (Anon, 1985). Abakaliki in Ebonyi State is one of the foremost rice growing areas of the country. Rice is predominantly grown in the entire agro-ecological zone under swamp or rain fed upland condition. There is however, an increasing concern about the continuous cultivation of upland rice in this area because of some factors, which tend to constrain its growth and development. The uneven distribution of rainfall during the cropping season and the crop invasion by stem borers are the major constraints.

Most rain fed upland rice farmers concentrate plantings during the wet season from July when they are sure of abundant and regular water supply. Plantings around this period enable harvest to coincide with the drier weather conditions necessary for threshing and milling of the produce. However, late plantings predispose rice plants to serious attack by some diseases and pests as a result of population build up from earlier plantings. Lal (1981) showed that delays in planting or transplanting may lead to reduction in yields of crops through shortening of grain fill period and premature senescence.

N-fertilization is an important nutrient in rice cultivation (as its application is seen to promote vegetative growth even though in some cases to the detriment of harvestable produce). At high levels, the modern cultivars tiller heavily, produce more grain per unit area of land and remain standing until harvest (Onwueme and Sinha, 1991). But high amounts of chemical fertilizer in rice fields have been shown to stimulate the outbreak of diseases and insect pests (Lee *et al.*, 1973). These results are confirmed by Raj and Morachan (1973) and Ukwungwu (1985) who obtained the highest infestations of rice leaf roller and stem borer in crops receiving higher doses of nitrogen fertilizer. In addition, *Saroja et al.* (1987) and Lawani (1992) reported higher incidents of pests like stem borer with incremental rate of nitrogen fertilizer.

Several species of stem borer – the white borer (*Maliarpha separatella*), the striped borer (*Chilo spp.*), the pink borer (*Sesamia calamistis)* and the yellow borer (*Scirpophaga sp*) attack rice in the field (Youdeowi, 2004). Stem borer is one of the major causes of low yield of rice in Nigeria (Alam and Efron 1986, Taylor 1999). The attack is more important in upland than low land rice (Anon, 1996). The use of insecticidal method of control is hampered by fears such as environmental degradation, pest resistance and unavailability when needed.

The objective of this study was to determine the optimum rate of nitrogen and the best transplanting date of rice that will ensure the most effective control of stem borer attacks and the highest grain yield.

Materials and Methods

The experiment was conducted at the Teaching and Research farm of Ebonyi State University, Abakaliki, Nigeria, during the 2003-cropping season. Abakaliki is located in a sub-humid agro-ecological zone at latitude 06^0 04^{IE}, longitude 08^0 05^{IE}, and altitude of 104.40 m above sea level. Rainfall is bimodal with an annual total average of 1969.54 mm. Field preparations were done manually by hoeing. A total land area of 44 m x 17m

(748 m^2) was marked out for the experiment. The experiment was laid out as a split-plot in a randomized complete block design (RCBD) and there were three replications. Transplanting dates were assigned to the main-plots, while nitrogen levels were assigned to the sub- plots. Three transplanting dates were used – July 31, August 14 and August 28, 2003. The sub-plot treatments were 0 kg N ha^{-1}, 80 kg N ha^{-1} and 160 kg N ha^{-1}. Nitrogen fertilizer in the form of urea was added in three split doses of 50% at the beginning, 25% as top dressing at four weeks after transplanting (i.e. at active tillering) and 25% top dressing at panicle initiation as appropriate for the applied N-plots. Basal applications of single super phosphate at 40 kg P ha^{-1} and muriate of potash at 40 kg K ha^{-1} were given to all the plots. Earth bunds of 1 m width and 0.75 m and 0.50 m high were erected to demarcate both the main plots and sub-plots respectively to avoid lateral nutrient drift. A susceptible rice variety, ITA 306 (FARO 37), was used for the experiment. Twenty-eight days old rice seedlings raised from nursery were transplanted in rows to each of the 5 m x 4 m (20 m^2) sub plots. Two seedlings were transplanted per stand at the spacing of 20 cm x 20 cm.

The experimental area was kept weed-free by hoe weeding three times. The field was allowed to be naturally infested with various species of stem borer. No pesticide was applied. Appropriate cultural agronomic practices were duly maintained. Data were kept on insect damage incidence of stem borer and on grain yield from 20 hills of rice randomly selected from the inner rows per plot. The tagged plants were later used for closer examination of the damage incidence expressed as percentage of tillers showing 'dead heart' (at 70 days after transplanting; DAT) and 'white head' symptoms (at 105 days after transplanting; DAT). Number of tillers lost at 105 DAT, was also used to estimate the damage incidence. The 'white head' symptom was expressed as tillers with dead or rotten basal leaf whorls and with the characteristic leaf feeding symptoms of stem borer on the leaf tops. "White head' symptom was expressed as tillers bearing unfilled whitish panicles. Tiller losses were estimated as the number of lodged tillers per 20-tagged hills per plot with stem borer feeding damage. Feeding damage was observed as 'window pane' effect on the young leaves, larvae entry/exit holes and dead or rotten flagged leaves with larvae feeding holes. Grain yield was estimated as the quantity of threshed paddy per 20-tagged hills per plot. The data collected were subjected to analysis of variance according to split-plot in a randomized complete block design. Damage percentages were subjected to arcsine transformation (arcsin $\sqrt{x}$, where x=percentage of damaged tillers per plot), before analysis of variance was carried out on them. The tiller losses were subjected to square root transformation, ($\sqrt{x+\frac{1}{2}}$, where x = average number of lodged tillers with characteristic stem borer damage), before analysis of variance of variance was carried out on them. Comparison of treatment means was done using the F-LSD procedure as outlined by Obi (2002).

Results and Discussion

The annual rainfall spreads between January and November of 2003. Monthly rainfall distribution, rain- days, temperature (minimum and maximum) as well as relative humidity (R.H %) of the experimental site were recorded in Table 1. The site was flat. Some soil properties before the commencement of the experiment were recorded in Table 2. The soil was classified as Dystric Leptosol (Anikwe *et al.*, 1999).

Table 1: Meteorological data of the experimental site (2003 farming season)

Month	Rainfall	Rain days	Temp Max. (°C)	Temp Min (°C)	R.H (%)[1]
January	4.60	3	27.05	13.18	43.82
February	0.00	0	26.59	16.32	52.60
March	14.30	2	30.65	17.42	56.10
April	98.60	9	28.22	17.05	76.40
May	301.20	13	27.90	15.79	73.80
June	NA	NA	28.84	18.57	79.70
July	383.25	20	24.86	13.90	84.10
August	517.24	23	23.50	15.26	94.28
September	240.65	18	24.45	16.58	94.75
October	390.90	14	24.92	15.61	93.88
November	8.80	3	27.95	16.22	90.25
December	-	-	-	-	-
Total	**1969.54**	**105**	**294.93**	**175.82**	**839.68**
Mean			**24.58**	**14.65**	**69.97**

Lat 06°04^N, Longitude 08°05^E NA= Value not available

Table 2: Chemical and Physical properties of soils of the experimental site in 2003

Parameter	Value
Total sand (%)	22
Total silt (%)	46
Total clay (%)	32
Field bulk density (gcm^{-3})	1.58
Field total porosity (%)	41
P^H (H_2O)	5.20
P^H (KCL)	4.80
Organic carbon (%)	1.52
Total N (%)	0.14
Exchangeable bases (cmol) (+) kg^{-1}	
Na	0.05
K	0.23
Mg	1.29
Ca	2.12
CEC	4.07
Available P (mg kg^{-1})	4.90

Incremental rates of nitrogen significantly increased damage ('dead heart' and 'white head' symptoms) by the stem borer (P = 0.05), with the highest rate of 160 kg N ha^{-1} resulting in significantly the highest incidence of damage (Table 3). Where there was no N- fertilization gave significantly the lowest stem borers damage. It is believed that high rates of nitrogen make plants more hydrated and succulent thereby resulting in greater susceptibility to herbivorous insect pests. This fact corroborates the findings by Lee *et al.* (1973) and Ukwungwu (1985). In a field trial involving graded doses of N-fertilizer, Ukwungwu (1985) obtained highest infestations of

Table 3: Effect of nitrogen rate and transplanting date on the percentage incidence of 'Dead heart' and 'White head' symptoms on rice tillers

Nitrogen (kg ha^{-1})	Time of Transplanting			
	Dead heart			
	July 31	August 14	August 28	Mean
0	0.6 (4.5)	17.8 (24.9)	38.2 (38.3)	18.9 (22.5)
80	3.3 (10.6)	26.3 (30.9)	55.0 (47.9)	28.2 (29.8)
160	15.0 (22.8)	32.8 (34.9)	70.6 (57.2)	39.5 (38.3)
Mean	6.1(12.8)	25.6(30.2)	54.6(47.8)	28.8(30.5)
		White head		
0	11.1(19.5)	16.7(24.1)	13.9(21.9)	13.9(21.8)
80	12.8(20.9)	20.6(27.0)	28.9(32.5)	20.7(26.8)
160	22.8(28.5)	46.1(42.8)	42.2(40.5)	37.0(37.3)
Mean	15.6(23.0)	27.8(31.3)	28.3(31.6)	23.9(28.6)
			Dead heart	White head
F-LSD $_{(0.05)}$ for comparing any two transplanting date means			5.6	6.4
F-LSD $_{(0.05)}$ for comparing any two nitrogen level mean			16.5	5.6
F-LSD $_{(0.05)}$ for comparing any two transplanting date x nitrogen			16.4	9.3

Data subject to arcsine transformation: transformed values in parentheses

Table 4: Effect of nitrogen rates and transplanting date on number of tillers lost from stem borer attack and grain yield (t ha^{-1})

Nitrogen (kg ha^{-1})	Time of Transplanting			
	July 31	August 14	August 28	Mean
		Number of tillers lost		
0	0.0 (0.7)	2.6 (1.8)	7.4(2.8)	3.3(1.8)
80	0.3 (0.9)	2.8 (1.8)	9.5(3.2)	4.2(2.0)
160	2.0(1.8)	3.7 (2.1)	12.7(3.6)	6.1(2.5)
Mean	0.8(1.1)	3.0 (1.9)	9.9(3.2)	4.5(2.1)
		Grain yield (t ha^{-1})		
0	2.9	3.3	2.8	3.0
80	3.6	4.9	5.0	4.5
160	3.6	4.4	4.5	4.1
Mean	3.4	4.2	4.1	3.9
			Number of tillers lost	Grain yield
F-LSD $_{(0.05)}$ for comparing any two transplanting date means			2.2	0.2
F-LSD $_{(0.05)}$ for comparing any two nitrogen level mean			1.2	0.2
F-LSD $_{(0.05)}$ for comparing any two transplanting date x nitrogen			2.5	0.4

Data subject to square root transformation: transformed values in parentheses

rice leaf roller and stem borer in crops receiving higher doses of fertilizer nitrogen.

There was a progressive but significant increase in the incidence of stem borer damage and tiller losses with increasing delay in the transplanting dates (P = 0.05) (Table 3 and 4 respectively). Significantly greater symptoms and stand losses were recorded when rice was transplanted on August 28 compared with earlier transplants on July 31 or August 14. Incidence and damage were also significantly higher in August transplanted rice than in July transplanted rice. The progressive increase in the stem borer damage was evidently due to the gradual build-up of the pest infestation from earlier plantings with progressing season. The build-up of the stem borer may also be as a result of the increase in the preferred and alternative hosts of the pest. Report by Anon (1996) showed that stem borer populations remain low during the early season but increased on rice and other alternate hosts causing serious economic damage to the late crops.

Interactions of dates of transplanting with N-fertilization were significant (P=0.05) for stem borer damage incidence and stand losses (Table 3 and 4 respectively). Transplants at 14th or 28th August with 160 kg ha^{-1} doses of nitrogen recorded the greatest damage incidence by the stem borer. This was attributed to the effect of nitrogen and water availability, which enhanced tissue hydration and succulence and therefore susceptibility to pest. On the other hand, no application of nitrogen at 0 kg ha^{-1} on July 31 transplants produced the least damage incidence. This value was significantly lower than other doses of nitrogen treated on various transplanting dates.

The highest grain yield of 4.5 t ha^{-1} was recorded at 80 kg N ha^{-1} while application of nitrogen fertilizer beyond 80kg N ha^{-1} depressed grain yield (Table 4). The level of 80 kg N ha^{-1} was therefore regarded as the optimum. Mbagwu (1990) recorded an optimum of 120 kg N ha^{-1} with maize. The yield depressions encountered in Mbagwu's report beyond such optimum dose was attributed to the impairment of other essential nutrient availability due to nutritional imbalance developed within the root zone.

That the transplanting date with the least damage incidence and stand losses did not produce the best grain yield suggests that the crop did not have initial vegetative growth of the crop during such early transplants. The shortening of the developmental period with late planting may have accounted for the depressed grain yield recorded for transplants made beyond August 14. The advantage of lower incidence of stem borer damage in the earlier transplants was therefore not adequate to offset the negative effect of late transplanting. Ogunlela *et al.* (1984) reported that every one week delay in planting cotton resulted in yield reduction of 12.5 kg ha^{-1} in Samaru Nigeria.

Generally interaction of N-fertilization and transplanting date that gave the least damage incidence was not the combination that produced the highest grain yields. High or low doses of N-fertilizer given to August 14 transplant produced lower yields. Application of 80 kg N ha^{-1} on rice transplanted on August 14 significantly produced the highest yield (P = 0.05). This suggests their combination potential for reduction of stem borer damage and increase grain yield.

References

Alam, M. S. and Efron, Y (1986). Resistance of rice to stalk eyed fly, Diopsis *macrophathalma* (Dalman). *Int.Rice Comm News*.35:40-45.

Anikwe, M.A.N., Okonkwo, C.I., Aniekwe, N.I. (1999). Effect of changing land use on selected soil properties in Abakaliki agro ecological zone south eastern Nigeria. *Environmental Education and Information 18(1), 79 – 84.*

Anonymous (1985). Introduction to rice production in Nigeria. In: Proceedings of the National Workshop on Rice Production Strategies in Nigeria pp 1-6.Organized by Federal Agriculture Coordinating Unit, Ibadan,Nigeria.

Anonymous (1996). Introduction to rice production in Nigeria. In: Proceedings of the National Workshop on Rice Production Strategies in Nigeria pp 2-6. Organized by Federal Agricultural Cordinating Unit, Ibadan, Nigeria.

Anonymous (1996). *Insect Pests of Nigeria Crops: Identification, Biology and Control.* Nigeria Federal Ministry of Agriculture and Natural Resources and the Overseas Development Administration of the British Government. Chatham, U.K.: Natural Resource Institute. P.253.

Lal, R. (1981). Clearing a tropical forest. 11. Effects on crop performance. *Field Crops Res 4:345-354*

Lawani, S.M. (1992). A review of the effect of various agronomic practices of cereal stem borer populations. *Tropical Pest Management:* 28(3): 266 – 276.

Lee, K.H.,E.J. Lee, K.S. Kim, W.J. Chu. and J.H. Kin (1973). Effects of diseases and pest control on rice yield in relation to various combinations of fertilizer application. Korean *Journal of plant protection.* 12:3339.

Mbagwu, J.S.C (1990). Maize (*Zea mays*) Responses to Nitrogen Fertilizer on an Ultisol in southern Nigeria under Two Tillage and Mulch Treatments *J. Sci Food Agric. 52: 365-376.*

Obi, I.U. (2002). Statistical Methods of Detecting Differences Between treatment means. Enugu. SNAAP Press Ltd.45pp

Ogunlela, V.B., V. Kumar and S.Mustafa (1984). Effect of sowing date on the performance of three cotton varieties in the southern cotton growing zone of Nigeria. *Samaru J. Agric Res.* 2 (1-2).

Onwueme, I.C., and T.D. Sinha (1999). *Field Crop Production in Tropical Africa.* The technical center for Agricultural and Rural Co-operation (CTA) publication, Wageningen, Netherlands p.480.

Raj, M.S., Y.B. Morachan (1973). Incidence of stem borer and leaf roller on IR-8 rice as influenced by fertilization and diazinon application. *Indian Journal of Agricultural Science. 43 (3): 290-294*

Saroja, R.J., Jagannathan and N.Raja (1987). Effect of N.nutrition and rice variety on leaf folder (LF), yellow stem borer (YSB) and grain yield. *IRRN.* 12.5.

Taylor, T.A. (1999). Crop Pests and Diseases. Studies in the Development of African Resources 4 (ed.Last, G.C., and A.C. Mabogunje). Oxford University Press. P.20-24.

Ukwungwu, M.N. (1985). Effect of nitrogen and carbonfuran on gall midge and white stem borer in Nigeria. *International Rice Research Newsletter* 10(6):19-20.

Youdeowei, A.(2004). *Integrated Pest Management Practices for the production of Cereals and pulses.* Ministry of Agriculture Plant Protection and Regulatory Service Directorate, Ghana, Sayce publishing. London. U.K. p47.