EFFECT OF NITROGEN AND PERIOD OF WEED INTERFERENCE ON MAIZE/RICE MIXTURE.

BY

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A Thesis submitted to Ahmadu Bello University Post-graduate school, in partial fulfillment of the requirements for the degree of Master of Science in Agronomy.

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DECLARATION

I hereby declare that this thesis has been written by me and that it is a record of my own research work. It has not been presented before in any previous application for a higher degree.

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CERTIFICATION

This thesis entitled **"EFFECT OF NITROGEN AND PERIOD OF WEED INTERFERENCE ON MAIZE/RICE MIXTURE"** by Aliyu Usman meets the regulations governing the degree of Master of Science in Agronomy of Ahmadu Bello University, Zaria, and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This work is dedicated to my wife Aisha, and my daughter Nabila, for all their love and patience during my Post graduate studies.

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ABSTRACT

A field experiment was conducted during 1994 and 1995 wet season on the research farm of the Institute for Agricultural Research, Samaru (11'11' N , 07°E 680m) located in northern Guinea savanna agro-ecological zone of Nigeria. The main objective was to investigate the effect of nitrogen level and period of weed interference on maize/rice mixture. The treatments consisted of three levels of nitrogen (0, 60 and 120kg/ha) and ten period of weed interference (weed free for 3,6,9, 12WAS and harvest and weed infested for the same period) . The treatment were laid out in a split plot design with nitrogen in the main plot and period of weed interference in the sub plots.

The result of this study revealed that increasing nitrogen from 0 to 120kg\ha significantly increased grain yield of maize up to the maximum of 2243 kg/ha and 3809 kg/ha in 1995 and 1995 respectively in treatments that were kept weed-free until 6,9,12WAS and harvest and those initially weed-infested for the first 3WAS. On the other hand, nitrogen application did not increase the grain yields of maize on the plots weed-infested until harvest and those kept weed-free initially for 3WAS. For rice, increasing nitrogen from 0 to 120kg/ha significantly increased grain yield up to the maximum of 933 and 1216 kg/ha in 1994 and 1995 respectively in treatments that were kept weed-free until 6,9,12 WAS and

harvest. Nitrogen application did not increase the grain yield of rice on the plots that were kept weed-free initially for 3WAS in both years and those weed-infested for 9WAS and more in 1995.

As compared with the crops kept weed-free throughout the lifecycle, uncontrolled weed growth resulted in 83.03% and 93.85% reduction in average grain yield for both years in maize and rice respectively. The critical period of weed interference in maize and rice mixture was established to be between 6 and 9WAS for maize and 5 and 9WAS for rice.

There was negative correlation between the maize grain yield and cumulative weed dry matter production (r=-0.028, r= -0.20 in 1994 and 1995 respectively) as well as weed cover scores (r= -0.33, r= -0.21 in 1994 and 1995 respectively). Rice grain yield was also negatively correlated with cumulative weed dry matter production (r= -0.20, r= -0.52 in 1994 and 1995 respectively) as well as weed cover scores (r= -0.21, r = -0.46 in 1994 and 1995 respectively). Other plant characters for maize and rice were highly positively correlated with the grain yield.

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CHAPTER ONE

1.0 INTRODUCTION

Mixed cropping is a system of growing two or more crops together on the same piece of land at the same time in a random or systematic manner that the growth of the component crops interact in space and time (Elemo *et al* 1988). This cropping system is most common among the small scale farmers in the developing countries of the tropics and sub tropics (Norman, 1974). The practice ensures optimum use of labour, more efficient utilization of environmental resources (light, water and nutrient), better utilization of land and may also suppress weeds, thereby reducing the cost of weed control and improving the quality of product (Okigbo and Greenland, 1976). Other benefits include, insurance against crop failure and reduction in the spread of diseases and pests (Anon; 1977).

Maize production in the savanna area has been popularised because of higher yield potential than sorghum and millet, the traditional staple cereal crops. Abundant sunshine, low incidence of disease and dry weather at the end of the growing season, have made savanna area a more favorable environment for maize production (Kowal *et al* 1975).

Rice is another important food crop in Nigeria, the production of which is rapidly expanding. This trend in cultivation could be traced to the ban imposed on the importation of rice by the Federal Government of Nigeria in

1985. Upland rice is often grown in mixture with other up land crops such as maize, sorghum, cowpea, and soybean in the Nigerian Savanna during the wet season. The productivity of these crop mixtures, most especially maize and rice is limited by nitrogen application which play a major role in the growth and development of these crops and hence increasing their grain yields (Russell, 1988). Nitrogen also promotes the growth of most weed species and there by leading to crop- weed competition. Weeding is a major labour input in crop management and accounting for 36 percent of the total labour requirement for crop production in Nigeria (Akobundu, 1987). However, unchecked weed growth in upland rice has been reported to cause severe yield reduction of about 80-100 percent (Akobundu and Fagade, 1978) while on maize, 40-60 percent yield reduction has been reported (Lagoke *et al* 1981). At present most research on weed association and crop nutrient levels have been on sole maize and rice but information on crop mixture is lacking. This study was carried out with the objective of determining the effect of nitrogen, period of weed interference in order to determine the critical period of weed interference on maize/rice mixture.

CHAPTER TWO

2 LITERATURE REVIEW

2.1 Effect of Nitrogen Fertilizer on Maize

Nitrogen is known to be one of the most limiting factor to the production of maize (Arnon, 1975). It plays a major role in the development and function of protoplasm, being an essential constituent of all proteins. Excess nitrogen in the soil however leads to luxury uptake by plants with resultant vegetative growth,while deficiency resulted in yellowing of foliage and poorly developed root systems (Olaitan and Lombin, 1988).

Maize response to the application of nitrogen has been reported by many workers. Goldsworthy (1967) reported that maize responded to the application of nitrogen fertilizer and recommended a rate of 65kgN/ha for maximum yield . However with the development of improved maize varieties, yield of at least twice as high have been reported under good levels of management (Jones, 1973).

Al-rudha and Al-younis (1978) and Nimje and Seth (1988)observed that increased application of 0 to 120kgN/ha reduced the number of days to 50% tasselling and silking and increased plant and ear height, number of grains and row per ear, 1000-grain weight, grain yield, crude protein and oil content, total nutrient and nitrogen content of flag leaf of maize. Similarly, Manaswamy *et al.* (1989) reported

significant increase in nitrogen uptake, grain yield and crude protein of maize with increased to 120kgN/ha. However, Ologunde and Ogunlela (1984) reported a rate of between 100-150kgN/ha to be optimum for maize production. Uyovbisere *et al.* (1990) observed highest grain yield of maize at between 80-100kg N/ha in the Nigeria savanna of Nigeria, while Elemo *et al.* (1992) observed that maize responded up to 75kgN/ha and reported an optimum rate of 100kgN/ha for maize production.

2.2 Effect of Nitrogen Fertilizer on Rice

The components which determine the grain yield of rice are number of panicle per plant, number of spikelets per panicle, the percentage filled grains and the weight of 1000-kernels (Seizo, 1967). Nitrogen, however, is the most limiting nutrient determining rice grain yield. Inadequate application of this nutrient causes yellow or pale green leaves with small, cells and thick walls while excessive application causes profused tillering, increase the percentage of spikelet sterility and decrease seed weight, thus impairing grain yield (Konokhova, 1985).

Hajra *et al.* (1984), working on the effect of nitrogen fertilizer on yield components of different mutants of rice (*oryza sativa L*) reported significant difference in response to fertilization as reflected in heading, plant height, panicle length, grain number per panicle and yield per plant. Thakur (1989) and Dalai and Dexil (1987) reported yield increase with application of up to 120kgN/ha. However, Nair

and Gautam (1992) observed paddy yield of 4.5, 4.6 and 5.0t/ha with 20, 40 and 60kg N/ha respectively. Husain and sharma (1991) reported that grain yield increased from 2.66t/ha without Nitrogen to 4.38t with 80kg N/ha. Kulhare (1991) found the highest economic return with the application of 100kgN/ha. Similarly, Singh and Bajpai (1990) reported highest grain yield with the application of 100kgN/ha. However, Rathore *et al.* (1991) observed yield increased with up to 80kgN/ha and reported the highest economic return with the same level of nitrogen. In Nigeria, application of 40kgN/ha was found to significantly increased grain yield of rice while higher rates did not increase yield (IITA 1985).

2.3 Effect of Nitrogen Fertilizer on Weed

Soil available nitrogen is affected by fertilizer application and by cultivation practices. High nitrate levels in the soil favours germination of weed seeds (Harper, 1977). In an experiment using 25 to 100kgN/ha and decreasing the number of manual weeding operations, weed dry matter production was reported to increased progressively (Gaffer, 1985). In contrast, Chaudler (1979) reported that nitrogen application of up to 220kgN/ha did not affect the dry matter production of any weed species, However, the concentration of nitrogen in the weeds was higher. Ahmed and Moody (1981) found that a delay in nitrogen until the first weeding resulted in reduced weed growth in rice. Similarly, Riyanto (1977)

reported that varying the rate and time of Nitrogen application had no effect on weed biomass Kondap *et al* (1987) reported that uptake of nitrogen by weeds increased with increasing nitrogen application and concluded that fertilizer use efficiency was highest with weed control and low level of nitrogen, but lowest with no weed control and higher nitrogen levels.

2.4 Effect of Period of Weed Interference on Maize

Weed competition cause very serious harm to maize growth and yield. In Nigeria losses of up to 60 percent have been reported due to unchecked weed competition (Lagoke *et al.*, 1981). Most earlier workers agreed that maize is most sensitive to weed competition during the first four weeks after planting, while weed growth before ten days or after 30 to 40 days appear to have less effect (Knake and Slife, 1965 and Nieto *et al.*, 1968).

Weed interference in maize was reported by Ayeni(1982) to be influenced by cropping season, cropping pattern, crop species and method of land preparation. Eke *et al* (1990) reported that interference of *Eleusine indica* and *Euphorbia heterphylla* reduced the fresh weight of maize by about 52 percent while an estimated grain yield losses of 0.54t/ha resulted from interference of these weed species. Similarly, Singh *et al* (1986) reported that hand pulling of weed at 60 days after planting increased yield by 63.2 percent while

hoeing at 25,40 and 60 DAP increased yields by 20.6, 23.0 and 46.3 percent respectively. Varshney (1991) reported that keeping field weedy up to 60 DAP reduced average grain yield by 43.8 percent relative to the weed free control. In another a study at Samaru, Nigeria maize crop kept weed free for the initial 29, 59 and 77 days after sowing (DAP) only had about 50, 20 and 10 percent loss in total yield respectively, while plot weed infested initially for 29 and 59 DAS had 20 and 50 percent loss in total yield respectively(Magani, 1990).

2.5 Effect of Period of Weed Interference on Rice

Weed interference in rice is known to reduce crop yield and to affect such yield components such as panicle number per square meter and number of grain per panicle (Ahmed and Moody, 1980; Akobundu and Ahissoy, 1984). Weed competition was reported to decrease plant characters such as plant height, tiller per plant, filled and unfilled grains per panicle and 1000 grain weight (Sultan *et al.*, 1986). It was also concluded that weed competition in upland rice could be tolerated until 40 days after transplanting, weeding between 20 and 40 days after transplanting was recommended. Yield losses due to weed competition in direct seeded rice depends on the weed community present. 90 percent yield loss was reported when weed community was grasses only, 10 percent loss when sedges and broad leaf weed dominated and 100 percent when the community was made up of grasses, sedges and broad

leaf weeds (IRRI,1968). Similarly, Okafor and De Datta (1974) reported that weed infestation caused yield reduction of 42 to 83 percent for drilled rice and 67 - 82% for broad cast seeded rice under upland conditions. The weed community of annual and *Cyperus rotundus* Linn. a noxious weed under upland condition resulted in the highest yield reduction of 82 and 83 percent under broadcast and drilled seed respectively . Gaffer (1985) reported increase in dry matter production when the number of weeding operation was decreased in a transplanted rice field and increased in rice yield when hand weeding is carried out at 20, 40 and 60 day after transplanting. Similarly, Bhan *et al* (1987) reported that two weedings at 15 and 45 DAS and 35 and 45 DAS in upland rice or three weedings at 15, 30 and 45 days after sowing resulted in more effective weed control than a single weeding operation alone.

2.6 **Effect of Period of Weed Interference on maize/rice mixture.**

One of the benefits that has been attributed to inter cropping is its ability to suppress weed better than a sole crop (Akobundu, 1980a). This is because of the more complete ground cover provided by crop in the inter cropping system. Bantilan and Harwood (1973) observed that weed growth was less when maize was intercropped with sweet potato or groundnut than in the sole crop of the component crops. Similarly, Pablico and Moody (1984) observed 11.9 percent of weed flora

on dry weight basis in rice/ sorghum cropping pattern as compared with 94.5 percent of weed flora in a continuous sorghum cropping. In contrast, there are other reports indicating no difference between inter crops and a sole crops with respect to weed growth. For example, weed growth in maize/groundnut inter crop was reported to be similar to that in sole maize (Punzalan, 1972), Pigeon pea was reported to make little or no contribution to weed suppression when it was inter cropped with other crops (Rao and Shetley, 1976). Inter cropping of maize or rice with cassava was reported not to contribute appreciably to weed suppression (Kass, 1976).

2.7 Critical Period of Weed Interference on Maize and Rice

The most susceptible period of crop growth to weed interference has been described as the critical period of weed interference (Nieto *et al.*, 1968). For most crops damage is irreparable with weed interference during the first few weeks of the growth period. If such damage could be avoided during this early period, subsequent weed growth is unlikely to have significant effect on yield. Sandhu and Gill (1973) identified the critical period of weed competition in maize to be two to six weeks after sowing with yield loss of to 47.2%. Chandra-Singh and Narayana Rao (1975) reported yield losses of 29 to 74 percent and the critical period of competition as the first month after sowing. Carson (1979) reported yield losses of 54% percent and identified the critical period of weed competition

to be first four weeks after sowing. At Samaru, Bakut (1985) reported yield losses of 92% due to unchecked weed growth in maize/chilli mixture and identified a period of 3 to 6WAS as the critical period of weed interference, while Magani (1990) reported a period of three to nine weeks after sowing as the critical period of weed competition in three maize varieties.

In rice, Sultan *et al.* (1986) reported that progressively longer period of weed competition decreased grain yield compared with competition for less than 30 days after transplanting followed by weed control until harvesting. Olivaveira and Almeida (1982) reported that weed developing between 45 and 60 days after seeding decreased rice yield, however, there was no significant decrease in yield with competition during the first 45 day after sowing. Similarly, Govinda Singh *et al* (1985) reported that weed competition during the first 15 days of drilling rice had no significant effect on paddy yield and competition beyond 15 DAS markedly decreased the yield.

CHAPTER THREE

3 MATERIALS AND METHODS

3.1 Experimental Site

A field experiment was conducted on the research farm of the institute for Agricultural Research, Samaru (longitude11"11'N, latitude 07"38'E and elevation of 680m above sea level) in the northern Guinea savanna ecological zone of Nigeria during the 1994 and 1995 wet seasons. Rainfall and other meteorological data collected during cropping are shown in Appendix A and B for 1994 and 1995 respectively.

The most prevalent weed species observed at the site of the trials were mainly grasses and sedges at the early stage of the crop growth and broad leaved weeds at the later stage of crop growth. Details of types of weed species and their level of occurance at the site of the trials are contained in Table 1.

3.2 Experimental Design and Treatments

The experiment was laid out in a split plot design with three replications. Three levels of nitrogen (0, 60 and 120kgN/ha) were assigned to the main plot while ten periods of weed interference were in the sub plot as the levels were: Plots kept weed free for 3,6, 9 and 12 weeks after sowing (WAS) and weed infested for 3, 6, 9 and 12 WAS. Two control

Table 1: LIST OF COMMON WEED SPECIES AT THE EXPERIMENTAL SITE, SAMARU,(1994 and 1995 WET SEASON).

Types of weeds	Level of infestation 1994	1995
Grasses		
Cydon dactylon (L.) pers	+	+
Digitaria horizontalis Walld	+++	+++
Eleusine indica (L.) Gsrtu	+++	+++
Erogrotis tenella. Trin. ex stend	+	+
Oldenladia corymbosa L.	+	+
Rottboellia cochinchinesis (L.)	+	+
Broad leaved weeds		
Acanthospamum hispidum DC	++	++
Amarathus spinosis L.	+	+
Celosia trigyna	+++	+++
Hypotis lanocelata	++	+
Vernonia ambigua kotohy and peyr	+++	+++
Sedges		
Cyperus esculentus L.	++	++
Cyperus rotundus L.	++	++

\+ = Low infestation

++ = Moderate infestation

+++ = Heavy infestation.

treatments in which the plots were kept weed free and weed infested until crop harvest were included for comparison.

3.3 Cultural Practices

3.3.1 Land preparation and layout

The land was ploughed, harrowed twice and ridged at 90cm spacing. Each sub plot in the layout consisted of six ridges that were six meters long giving a total area of 32.4m^2 while the net plot consisted of four ridges of six meters long giving an area of 21.6m^2. The ten soil samples taken randomly from 0 - 15cm soil depth before planting and bulked for the determination of the soil for physio chemical properties. The results are shown in Table 2.

3.3.2 Crop establishment

Maize cv TZBSR-W, released by International Institute of Tropical Agriculture (IITA) Ibadan in 1974, a late maturing variety (100 - 120 days), with white grains and resistance to streak (IITA, 1992) and rice cv. ITA 257 also early maturing variety (95 days) with resistance to blast and low shattering panicle trait (Anon, 1981) developed by IITA were used in this trial.

About three to four seeds of maize were sown per stand on the 27th June, 1994 and 3rd July, 1995 at an intra-ridge spacing of 20cm, Seedlings were thinned to two plants per hill two

Table 2: Physical and chemical properties of the soild of the experimental site in Samaru during the 1994 and 1995 wet season.

	Season	
	1994	1995
Physical properties		
Sand (%)	66.8	50.0
Silt (%)	17.3	36.0
Clay (%)	15.9	14.0
Textural class	Sandy loam	Loam
Chemical properties		
pH in water	5.0	5.1
pH in $Cacl_2$ (o.o1m)	4.2	4.4
Organic carbon (%)	0.17	0.32
Total mitrogen (%)	0.03	0.07
Available phosphorus (ppm)	14.4	5.38
Exchangeable Calcium (meq/100g soil)	1.40	3.28
Exchangeable Magnessium (meq/100g soil)	0.42	0.80
Exchangeable Potassium (meq/100g soil)	0.36	0.35
CEC	6.20	5.2

weeks after sowing (WAS) to maintain a maize population of 55,555 plants/ha.

Six seeds of rice were sown per stand on the 29th June, 1994 and 4th July, 1995 at a spacing of 30cm x 30cm between the ridges of maize in an additive mixture and later thinned to two plants per hill to attain a density of 74,074 plants/ha. Thus the planting pattern was one ridge of maize, alternated by two rows of rice on the flat.

3.3.3 Fertilizer application

Fertilizers were applied to all the plots two weeks after sowing (WAS) at the rate of 13kg P/ha and 25kg K/ha using single super phosphate and muriate of potash, respectively. Nitrogen was equally split-applied at two and seven WAS according to the treatments using urea.

3.4 Data collection

3.4.1 Maize

3.4.2 Plant height

Height of five plants of maize were taken from the discard rows at physiological maturity by measuring from ground level to the tip of tassel.

3.4.3 Plant dry weight

The same plant used for height measurement were cut at

ground level, cleaned and separated into leaves and stems, oven dried at 70°C to constant weight for 24 hours to determine the plant dry weight.

3.4.4 Number of days to 50% tasseling

Number of days from planting to when 50% of maize plants in the net plot have tasseled was recorded.

3.4.5 Leaf area index

Leaf area of maize was determined by measuring the length and width of every leaf in five randomly selected plants, then averaged and multiplied by a factor of 0.8 (Watson, 1952) at crop maturity. The average leaf area was then divided by the land area covered by every plant,

$$LAI = \frac{\text{Leaf area}}{\text{Land area}}$$

3.4.6 Number of cobs, cob length, cob diameter, and kernel depth

The number of maize cobs in each net plot was counted at physiological maturity. Also cob length, cob diameter and kernel depth of five randomly selected cobs from each net plot were measured.

3.4.7 **Shelling percentage**

Maize cobs from each net plot were collected and weighed, then shelled and the shelling percentage was then calculated as follows

$$\text{Shelling percentage} = \frac{\text{Grain weight after shelling}}{\text{cob weight}} \times 100$$

3.4.8 **Grain yield**

The harvested cobs of maize from net plots were shelled, sun dried to about 14% moisture content and later winnowed. The grains were then weighed.

3.4.9 **Hundred grain weight**

Hundred grains were counted per plot and the weight was determined.

3.5 **Rice**

3.5.1 **Plant height**

Height of five rice plants were taken outside the net plots at physiological maturity by measuring from ground level to the tip of panicle.

3.5.2 Plant dry weight

The five rice plants used for height measurement were cut at the ground level, cleaned and separated into leaves and stems, oven dried at 70°C for 24 hours to constant weight.

3.5.3 Number of days to 50% anthesis

Number of days from planting to when 50% of rice plants in the net plot have flowered.

3.5.4 Leaf area index

Leaf area was determined by measuring the length and width of every leaf in five randomly selected plants, then averaged and multiplied by a factor of 0.7 (Watson, 1952) at crop maturity. The average leaf area was then divided by the ground area cover by every plant.

$$LAI = \frac{\text{leaf area}}{\text{ground area}}$$

3.5.5 Number of panicles and panicle length

The number of rice panicles in each net plot was counted at physiological maturity and also panicle length of five randomly selected rice plants in the net plot was also measured.

3.5.6 Number of filled grains per panicle and percentage unfilled grains

These observation were only taken in 1995. The number of filled grains and percentage unfilled grains were determine according to Gomez (1972).

3.5.7 Threshing percentage

The panicles harvested from each net plots were weighed and then threshed for the grain weight after threshing. The threshing percentage was then calculated as follows.

$$\text{Threshing percentage} = \frac{\text{Grain weight after threshing}}{\text{panicle weight (un threshed)}} \times 100$$

3.5.8 Grain yield

The harvested panicles of rice from each plot were threshed, sun dried to constant weight and later winnowed. The grains were then weighed.

3.5.9 Thousand grain weight

Thousand grains were counted per plot and the weight was determined.

3.6 Weeds

3.6.1 Weed cover score

Weed cover score was taken at crop maturity. A scale of 0 to 10 was used where 0 represent no weed cover and 10 represents complete weed cover.

3.6.2 Weed dry matter production

Weed samples were collected from one meter square quadrats in each plot before every weeding operation was carried out at 3, 6, 9, and 12 WAS and at harvest. The samples were cleared free of soil, weighed and oven dried at 70°C to constant weight for dry matter determination.

3.7 Data analyses

The data were subjected to analysis of variance for test of significance and treatment means were compared using Duncan Multiple Range Test at 5% level of probability. Correlation coefficient and Regression analyses were carried out on the appropriate parameters.

Predicted yields of maize and rice grains as affected by periods of weed interference were determined using quartic regression equation (GOMEZ and GOMEZ, 1984)

$$y = a + b_2z_2 + b_3z_3 + b_4z_4$$

where

y = yield/weed dry matter production z_2, z_3 and z_4 are functions of time of weeding period, such that slope is zero at t = 0 (time of sowing) and to 15 (time of harvesting) and a; b_2, b_3 and b_4 are regression in quartic form is

$$y = a + bt + b_2t^2 + b_3t^3 + b_4t^4$$

The equation for relationship of yield/weed dry matter production and weeding time which has a zero slope at both t = 0 and t = 15 weeks.

CHAPTER FOUR

4. RESULTS

4.1 Effect of Nitrogen and Period of Weed Interference on Grain Yield, Shelling Percentage, Cob number Per Square Meter and 100-grain weight of maize.

4.1.1 Grain yield of maize

Maize grain yield increased significantly with increase in nitrogen application up to 120kg/ha in both year (Table 3).

The Effect of period of weed interference on grain yield of maize was significant in both years (Table 3). Plots kept weed-free initially for 6, 9, 12 WAS and until harvest and those weed infested initially for 3 WAS produced significantly higher grain yields than those weed infested for 9 WAS and more and those kept weed-free for 3 WAS only. Plots weed infested initially for 9 WAS in 1995 and 12WAS in 1994 produced grains yields that were comparable to the corresponding plot weed infested througout the crop life-cycle. Uncontrolled weed growth throughout the crop life-cycle resulted in 85.61% and 80.45% reduction in maize grain yields in 1994 and 1995 respectively compared with those kept weed-free throughout the crop life-cycle.

The interaction of nitrogen and period of weed interference on grain yield of maize was significant in both

Table 3: Effect of nitrogen levels and period of weed interference on grain yield, shelling percentage, cob number per unit area, and 100 - grain weight of maize at Samaru (1994 and 1995 wet season).

Treatments	Grain Yield (kg/ha)		Shelling Percentage (%)		Cob number/m^2 (no)		100-grain weight (g)	
	1994	1995	1994	1995	1994	1995	1994	1995
Nitrogen levels (kg/ha)(N)								
0	149c	130c	57b	39b	2c	3	15.5b	11.9b
60	945b	1234b	74a	57a	3b	5	17.3a	15.6a
120	1511a	2256a	78a	68a	4a	6	18.2a	17.0a
SE ±	101.8	126.3	3.7	3.8	0.3	1.0	0.32	0.75
Period of weed interference (W)								
Weed free for 3 WAS	217cd	652de	72a	52b	3b	3de	15.6cd	13.5abc
Weed free for 6 WAS	1108a	1313bc	79a	58ab	4a	4cd	17.6ab	13.8abc
Weed free for 9 WAS	1267a	1763ab	74a	58ab	3b	5bc	17.3ab	14.5ab
Weed free for 12 WAS	1345a	1930a	68a	61ab	4a	5bc	18.4a	15.1ab
Weed free until harvest	1320a	1944a	71a	72a	4a	6b	18.2a	16.8a
Weed infested for 3 WAS	1085a	1818ab	66ab	56ab	3b	5bc	17.0b	14.8abc
Weed infested for 6 WAS	975ab	1035cd	74a	65ab	4a	8a	16.7b	16.8a
Weed infested for 9 WAS	613bc	600e	68a	26d	3b	3de	16.6bc	10.3c
Weed infested for 12 WAS	511cd	634e	69a	49bc	3b	3de	17.7ab	12.0bc
Weed infested until harvest	190d	380d	55b	31cd	2c	2e	14.6d	10.6bc
SE ±	110.6	146.7	4.0	6.1	0.2	1.2	0.35	1.54
Interaction (NxW)	**	**	*	*	**	NS	**	NS

In a column of each factor, means followed by the same letter with a treatment are not significantly difference at 5% level of probability using DMRT.
* Significant at 5% level. ** significant at 1% level.
NS = Not Significant
WAS = Weeks after Sowing.

years (Table 4 and 5). Nitrogen application did not have soignificant effect on grain yield of maize on the plots that were kept weed free initially for 3 WAS and those weed infested on till harvest in both years and those weed infested for 9 WAS in 1995. In 1994, grain yield of plots kept weed free initially for 6 and 12 WAS and until harvest and those weed infested initially for 3 WAS increased significantly with increase in nitrogen application up to 120kg N/ha, while there was no significant increase in grain yield beyond 60kg N/ha on the plots kept weed-free for 9 WAS and those weed-infested for 6 WAS. The grain yields of the plots weed-infested initailly for 9 and 12 WAS only significantly increased by nitrogen application at 120kg N/ha compared with no nitrogen. Similarly, In 1995, grain yield obtained from the plots kept weed-free for 9 and 12 WAS and until harvest and those weed infested initially for 3 WAS only increased significantly with increase in nitrogen application. However, application of 60 and 120 kg N/ha on plots kept weed free for 6 WAS and those weed infested for 6WAS produced grain yield that were similar but significantly higher than 0kg N/ha, while only 120kg N/ha resulted in significantly higher grain yield than no nitrogen on the plots weed infested for 12 WAS.

Table 4: Interaction* of nitrogen levels and period of weed interference on grain yield of maize at Samaru (1994 wet season).

Periof of Weed Interference (W)	Nitrogen level(Kg/ha) (N) 0	60	120
	----------kg/ha---------		
Weed free for 3 WAS	91g	145g	576g
Weed free for 6 WAS	247g	1065ef	2013abc
Weed free for 9 WAS	183g	1618bf	1999abc
Weed free for 12 WAS	210g	1581be	2243a
Weed free Until harvest	289g	1524c-e	2147ab
Weed infested for 3 WAS	210g	1153ef	1891a-d
Weed infested for 6 WAS	140g	1308de	1483cde
Weed infested for 9 WAS	43g	604fg	1190ef
Weed infested for 12 WAS	46g	221g	1265ef
Weed infested until harvest	29g	238g	304g
SE_a±		191.7	
SE_b ±		208.4	

* In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.

Table 5: Interaction* of nitrogen level and period of weed interference on grain yield of maize at Samaru (1995 wet season).

Periof of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	----------kg/ha---------		
Weed free for 3 WAS	94hij	754d-j	1108c-h
Weed free for 6 WAS	92hij	1488b-f	2359b
Weed free for 9 WAS	123gh	1540b-e	3627a
Weed free for 12 WAS	155gh	1825bc	3809a
Weed free Until harvest	309f-j	1817bc	3706a
Weed infested for 3 WAS	223gh	1616bcd	3615a
Weed infested for 6 WAS	255gh	1627bcd	1224c-g
Weed infested for 9 WAS	29ij	766d-j	1006c-i
Weed infested for 12 WAS	25ij	425e-j	1451b-f
Weed infested until harvest	10j	484e-j	654d-j
SE_a ±		178.1	
SE_b ±		203.4	

* In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a ± = For comparing means with same level(s) of N

SE_b ± = For comparing means of NxW.

4.1.2 Shelling percentage

Shelling percentage was significantly increased by nitrogen application in both years (Table 3). Further increase of nitrogen application beyond 60kg/ha did not increase shelling percentage of maize in the study.

The effect of period of weed interference on shelling percentage in both years was significant (Table 3). In 1994, cobs from the plots kept weed-free initially for 3 WAS and more and those weed infested for 6, 9 and 12 WAS had significantly higher shelling percentage than those of the plots infested throughout the crop growth. However, in 1995, cobs of plots kept weed-free for all the periods and those infested for 3 and 6 WAS had higher shelling percentage than those of the plots weed infested throughout. Plots weed infested initially for 12 WAS and those kept weed-free for 3 WAS only also produced cobs with lower shelling percentage than the maximum with those kept weed-free throughout.

The interaction of nitrogen and period of weed interference on shelling percentage was significant in both years (Table 6 and 7). In 1994, application of 60 and 120kg N/ha on plots kept weed-free for 12 WAS and those weed-infested for 3 WAS resulted in cobs with similar and significantly higher shelling percentage than no nitrogen application. However, in all the other weed interference periods, nitrogen application did not have any significant effect on the shelling percentage of maize application.

Table 6: Interaction* of nitrogen level and period of weed interference on shelling percentage of maize at Samaru (1994 wet season).

	Nitrogen level (Kg/ha) (N)		
Periof of Weed Interference (W)	0	60	120
	--------- Percentage -----		
Weed free for 3 WAS	67a-f	87a	62a-f
Weed free for 6 WAS	77abc	74a-d	85ab
Weed free for 9 WAS	61a-f	82abc	80abc
Weed free for 12 WAS	44ef	79abc	80abc
Weed free Until harvest	59b-f	74a-d	80abc
Weed infested for 3 WAS	41f	75a-d	81abc
Weed infested for 6 WAS	50def	85ab	86a
Weed infested for 9 WAS	55c-f	68a-e	81abc
Weed infested for 12 WAS	68a-e	57c-f	79abc
Weed infested until harvest	42ef	59b-f	65a-f
SE_a ±		8.2	
SE_b ±		7.7	

* In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.

Table 7: Interaction* of nitrogen level and period of weed interference on shelling percentage of maize at Samaru (1995 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	--------- Percentage -----		
Weed free for 3 WAS	38cde	54a-d	65abc
Weed free for 6 WAS	39cde	73a	62abc
Weed free for 9 WAS	40b-e	64abc	68abc
Weed free for 12 WAS	40b-e	71a	71a
Weed free Until harvest	62abc	76a	77a
Weed infested for 3 WAS	50a-e	54a-d	65abc
Weed infested for 6 WAS	62abc	67abc	65abc
Weed infested for 9 WAS	22e	37cde	69ab
Weed infested for 12 WAS	31e	66abc	78a
Weed infested until harvest	20e	39cde	55a-d
SE_a ±		11.2	
SE_b ±		10.8	

* In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.

In 1995, application of nitrogen resulted in no significant differences in shellin perecentage on plots kept weed free for 3, 9 WAS and until harvest and those weed infested for 3 and 6 WAS, while application of 60 and 120kg N/ha resulted in higher shelling percentage than no nitrogen on plots kept weed free for 12 WAS and those weed infested for 12 WAS. However, application of 120kg N/ha on plots weed-infested for 9WAS and until harvest resulted in higher shelling percentage than no nitrogen application and application of 60kg N/ha resulted in higher shelling perecntage than no nitrogen on plot kept weed-free for 6 WAS.

4.1.3 **Cob number per square meter**

The number of maize cobs increased significantly with increase in nitrogen application in 1994. However, in 1995, nitrogen did not has a significant effect on number of maize cobs (Table 3).

The effect of period of weed interference on cob number of maize was significant in both years (Table 3). In 1994, cob number obtained from plots kept weed-free initially for 3 and 9 WAS and those weed-infested for 3, 9, and 12 WAS and until harvest were significantly lower than those of the plots that was kept weed-free throughout. However, weed infestation until harvest produced lower number of cobs than other periods of weed interference. In 1995, the maximum number of cobs was obtained from plots weed infested for 6 WAS. Number of cobs obtained from plots kept weed-free for 9 WAS and more and those weed infested for 3 WAS were similar and significantly

higher than those of the plots kept weed free for 3 WAS and those infested for 9 WAS and more.

The interaction of nitrogen and period of weed interference on cob number was significant in 1994 (Table 8). On the plots kept weed free initially for 9 and 12 WAS and those weed infested for 3, 6 and 9 WAS. Nitrogen application at 60 and 120kg N/ha similarly significantly increased number of maize cobs compared with no nitrogen application. While only 120kg N/ha significantly increased number of cobs compared with no nitrogen on the plots kept weed free and those weed infested until harvest. The nutrient did not have effect on cob number on the plots kept weed free initially for 3 and 9 WAS. However, on the plots weed infested for 12 WAS, 120kg N/ha resulted in higher cob number than 0 to 60kg N/ha.

4.1.4 **100 grain weight**

Nitrogen application had significant effect on 100 grain weight of maize in both years (Table 3). Further increase of nitrogen application beyond 60kg/ha did not increase 100-grain weight of maize.

The effect of period of weed interference on 100-grain of maize was significant in both years (Table 3). Plots kept

Table 8: Interaction* of nitrogen level and period of weed interference on cobs number per square meter at Samaru (1994 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	---------- number/m^2 -------		
Weed free for 3 WAS	3b-e	3b-e	3b-e
Weed free for 6 WAS	4ab	4ab	5a
Weed free for 9 WAS	1g	4ab	5a
Weed free for 12 WAS	3b-e	5a	5a
Weed free Until harvest	3b-e	4ab	5a
Weed infested for 3 WAS	2d-g	4ab	5a
Weed infested for 6 WAS	2d-g	4ab	5a
Weed infested for 9 WAS	2d-g	4ab	4ab
Weed infested for 12 WAS	2d-g	2d-g	4ab
Weed infested until harvest	1g	2d-g	3b-e
SE_a ±		0.4	
SE_b ±		0.5	

* In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.

weed-free for 6 WAS and more in 1994 and 3 WAS and more in 1995 as well as the those infested initially for 12 WAS in 1994 and 3 and 6 WAS in 1995 produced 100-grain weight comparable to those of the plots kept weed-free throughout. The plots weed infested throughout produced lower 100-grain weight than all the other treatments except those kept weed-free for only 3 WAS in 1994.

The interation of nitrogen and period was significant only in 1994 (Table 9). Application of 60kg N/ha resulted in significantly lower 100-grain weight of maize than 0 and 120kg N/ha on the plots that were kept weed-free initially for 3 and 6 WAS. Weight of 100-grains on the plots kept weed-free initially for 9 and 12 WAS and harvest as well as those infested for 12 WAS and harvest were significantly lower without nitrogen than with nitrogen application. With weed infestation for 3 WAS, 100-grain weight of maize increased with nitrogen application while no significant difference was observed on 100-grain weight with nitrogen application on plots weed infested for 6 and 9 WAS.

4.2 Effect of Nitrogen and Period of Weed Interference on Cob length, Cob diameter and Kernel depth of maize

4.2.1 Cob length of maize

Cob length increased significantly with increase application of upto 60kg N/ha in 1994, while in 1995, it

Table 9: Interaction* of nitrogen level and period of weed interference on 100-grain weitht of maize at Samaru (1994 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	---------- (g)---------		
Weed free for 3 WAS	17.7cd	13.3hi	15.7efg
Weed free for 6 WAS	19.3abc	15.1e-h	18.5bc
Weed free for 9 WAS	13.4hi	19.2abc	19.4abc
Weed free for 12 WAS	14.6gh	20.0ab	20.7a
Weed free Until harvest	16.5de	18.7bc	19.4abc
Weed infested for 3 WAS	12.6i	17.8c	20.6a
Weed infested for 6 WAS	16.2d-g	16.1d-g	17.8cd
Weed infested for 9 WAS	16.7de	16.9de	16.2d-g
Weed infested for 12 WAS	15.2e-h	19.3abc	18.7bc
Weed infested until harvest	12.7 i	16.4def	14.7fgh
SE_a ±		0.61	
SE_b ±		0.54	

*In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.

increased by up to 120kg N/ha (Table 10).

The effect of period of weed interference on cob length was significant in both years (Table 10). Length of cobs obtained in 1994 from the plots that were initially kept weed-free for more than 6 WAS and those weed infested for 3 and 6 WAS only are similar and significantly longer than those of other weed interference period. In 1995, the plots weed-infested initially for 12 WAS and more produced significantly shorter cobs than the maximum obtained on the plots kept weed-free throughout.

The interaction of nitrogen and period of weed interference on cob length was significant in 1995 (Table 11). Cob length did not differ significantly with nitrogen application on the plots kept weed-free for 9 and 12 WAS and until harvest as well as those weed-infested initially for 6, 9 and 12 WAS. Application of 120kg N/ha significantly increased cob length compared with no nitrogen on the plots kept weed-free for 3 WAS and those infested throughout. While application of 60 and 120kg N/ha increased cob length on the plots kept weed free for 6 WAS and those infested for 3 WAS.

4.2.2 Cob diameter of maize

Cob diameter was increased significantly by nitrogen application in both years (Table 10).

Table 10: Effect of nitrogen levels and period of weed interference on cob length, cob diameter and kernal depth of maize at Samaru (1994 and 1995 wet season).

Treatments	Cob length (cm)		Cob diameter (cm)		Kernal depth (cm)	
	1994	1995	1994	1995	1994	1995
Nitrogen levels (kg/ha)(N)						
0	9.0b	8.1c	2.9b	3.1b	0.9	1.1b
60	13.0a	11.3b	3.9a	4.0a	1.3	1.5a
120	14.6a	13.5a	4.2a	4.4a	1.4	1.6a
SE ±	0.71	0.48	0.19	0.11	0.10	0.05
Periof of weed interference (W)						
Weed free for 3 WAS	11.0b	11.9abc	3.5b	4.0b	1.1b	1.5ab
Weed free for 6 WAS	14.1a	11.9abc	4.0a	4.4a	1.3ab	1.6a
Weed free for 9 WAS	13.5a	12.5a	3.9a	4.1ab	1.4a	1.4abc
Weed free for 12 WAS	14.2a	12.2ab	4.0a	4.2ab	1.3ab	1.4abc
Weed free until harvest	13.1a	13.6a	3.9a	4.4a	1.3a	1.7abc
Weed infested for 3 WAS	13.1a	12.5a	3.8ab	4.1ab	1.3ab	1.6a
Weed infested for 6 WAS	12.7a	10.1bcd	3.8ab	3.5c	1.3ab	1.4ab
Weed infested for 9 WAS	11.1b	9.6cd	3.8ab	3.9bc	1.2abc	1.5a
Weed infested for 12 WAS	10.4b	8.3de	3.0c	3.1d	0.9c	1.1bc
Weed infested until harvest	9.1c	6.9e	2.8d	2.6e	0.8c	0.9c
SE ±	0.55	0.78	0.11	0.20	0.07	0.11
Interaction (NxW)	NS	**	NS	**	**	NS

In a column of each factor, means followed by the same letter with a treatment are not significantly difference at 5% level of probability using DMRT.

* Significant at 5% level. ** significant at 1% level.

NS = Not Significant

WAS = Weeks after Sowing.

Table 11: Interaction* of nitrogen level and period of weed interference on cob length maize at Samaru (1995 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	---------- (cm)---------		
Weed free for 3 WAS	9.6c-j	11.5a-h	14.6abc
Weed free for 6 WAS	7.4f-k	13.5a-c	14.8ab
Weed free for 9 WAS	10.7a-j	11.7a-g	15.2ab
Weed free for 12 WAS	11.4a-i	10.3b-j	14.8ab
Weed free Until harvest	11.0 a-j	14.0a-d	15.9a
Weed infested for 3 WAS	12.0 g-k	12.6 a-f	12.9 a-e
Weed infested for 6 WAS	6.0g-k	11.6a-h	12.7a-j
Weed infested for 9 WAS	8.1 e-k	10.0c-j	10.8a-j
Weed infested for 12 WAS	4.6 h-k	9.1d-j	11.3a-i
Weed infested until harvest	1.0 k	8.6 d-k	12.1 a-g
SE_a ±		1.35	
SE_b ±		3.58	

*In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a ± = For comparing means with same level(s) of N

SE_b ± = For comparing means of NxW.

The effect of period of weed interference on cob diameter was significant in both years (Table 10). Plots kept weed-free initially for 6 to 12 WAS in both years and those weed infested initially for 3, 6 and 9 WAS in 1994 and for 3 WAS only in 1995 produced similar cob diameter to the maximum obtained from the plots kept weed-free throughout and significantly higher than those of the crop infested for 12 WAS and until harvest in both years. The least cob diameter was obtained from crop weed-infested until harvest.

The interaction effect of nitrogen and period of weed interference on cob diameter was significant only in 1995 (Table 12). In all the plots kept weed free initially for various periods and those infested initially for 3 WAS, there was no difference in cob diameter due to nitrogen application. However, 60 and 120kg N/ha significantly increased cob diamter in plots weed infested for 6 WAS and 9 WAS respectively. With infestation for 12 WAS and until harvest, application of 60 and 120kg N/ha significantly increased cob diameter.

4.2.3 **Kernel depth of maize**

Kernel depth was increased significantly by up to 60kg N/ha in 1995 (Table 10).

The effect of period of weed interference on kernel depth was significant in both years (Table 10). Similar results of kernel depth were obtained in both years. Crops kept weed-

Table 12: Interaction* of nitrogen level and period of weed interference on cob diameter of maize at Samaru (1995 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	---------- (cm)---------		
Weed free for 3 WAS	3.8a-d	3.8a-d	4.4ab
Weed free for 6 WAS	4.1abc	4.5a	4.7a
Weed free for 9 WAS	3.7a-d	4.2abc	4.5a
Weed free for 12 WAS	4.0a-d	4.0a-d	4.6a
Weed free Until harvest	4.0a-d	4.4ab	4.6a
Weed infested for 3 WAS	4.0a-d	4.1abc	4.3ab
Weed infested for 6 WAS	2.2de	4.4ab	4.0a-d
Weed infested for 9 WAS	2.4b-e	3.9a-d	4.5a
Weed infested for 12 WAS	1.8 ef	3.5a-d	3.9a-d
Weed infested until harvest	1.0 f	3.8 a-d	4.1abc
SE_a ±		0.72	
SE_b ±		0.68	

*In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.

free for various periods and those weed-infested for 3, 6 and 9 WAS had similar depth of kernel to the appropriate maximum.

The interaction of nitrogen and period of weed interference on kernel depth was significant in 1994 (Table 13). Kernel depths of cobs produced on the plots kept weed - free for 6 and 9 WAS and those infested initially for 12 WAS higher with the application of 120kg N/ha compared with no nitrogen. Similarly, on the plots kept weed-free until harvest and those infested for 6 WAS, application of 60 and 120kg N/ha significantly produced higher kernel depth than no nitrogen application. Nitrogen application did not have significant effect on kernel depth of maize in the other weed interference periods.

4.3 Effect of Nitrogen and Period of Weed Interference on Plant Height, Plant Dry Weight, Number of Days to 50% Tasseling and Leaf Area Index of Maize at Maturity

4.3.1 Plant height of maize

Plant height was increased significantly by the application of nitrogen in 1995 (Table 14).

The effect of period of weed interference on plant height was significant in both years (Table 14). Height of plants initially kept weed free until 6, 9,12 WAS and harvest in both years of experiment and those initially weed-infested

Table 13: Interaction* of nitrogen level and period of weed interference on Kernal depth of maize at Samaru (1994 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	---------- (cm)---------		
Weed free for 3 WAS	0.9e-j	1.1c-j	1.3a-h
Weed free for 6 WAS	1.0d-j	1.4a-f	1.6abc
Weed free for 9 WAS	1.0d-j	1.4a-f	1.8a
Weed free for 12 WAS	0.9e-j	1.5a-e	1.4a-f
Weed free Until harvest	0.7jk	1.5a-c	1.7ab
Weed infested for 3 WAS	0.9e-j	1.4a-g	1.5a-e
Weed infested for 6 WAS	0.7 jk	1.6ab	1.5a-e
Weed infested for 9 WAS	1.3ef	1.2h-i	1.4a-f
Weed infested for 12 WAS	0.5k-l	0.8h-k	1.2b-j
Weed infested until harvest	0.2h-i	0.9e-j	1.1e-j
SE_a ±		0.16	
SE_b ±		0.14	

*In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.

Table 14: Effect of nitrogen levels and period of weed interference on plant height, plant dry weight, number of days to 50% tasseling and leaf area index of maize at Samaru (1994 and 1995 wet season).

Treatments	Plant height (cm)		Plant dry weight (g)		Number of day to 50% tasseling		Leaf area index	
	1994	1995	1994	1995	1994	1995	1994	1995
Nitrogen levels (kg/ha) (N)								
0	95	109b	67b	24c	68	66	1.3b	1.3
60	142	174a	143a	59b	68	65	2.4a	2.0
120	149	185a	193a	129a	69	65	3.0a	2.3
SE ±	20.1	7.8	14.2	6.2	0.8	0.8	0.20	0.19
Period of weed interference (W)								
Weed free for 3 WAS	126bc	149bc	121b	71b	69	66ab	2.2bc	1.9
Weed free for 6 WAS	141ab	158abc	169a	56c	68	66ab	3.0a	2.2
Weed free for 9 WAS	150a	171ab	174a	80a	68	66ab	2.6ab	2.0
Weed free for 12 WAS	150a	152abc	182a	76a	68	65bc	2.7a	2.5
Weed free until harvest	151a	170a	179a	80a	69	66ab	2.5ab	1.9
Weed infested for 3 WAS	136ab	173a	174a	78a	68	65bc	2.6ab	2.0
Weed infested for 6 WAS	127bc	158abc	103b	75a	69	64c	1.9cd	1.6
Weed infested for 9 WAS	112c	146c	95b	64bc	69	66ab	1.7cd	1.5
Weed infested for 12 WAS	112c	140cd	87b	55c	68	66ab	1.7cd	1.6
Weed infested until harvest	109c	133d	88b	57c	69	67a	1.3d	1.5
SE ±	6.1	8.9	13.1	5.7	0.2	0.4	0.20	0.31
Interaction (NxW)	NS	NS	NS	**	NS	NS	NS	NS

In a column of each factor, means followed by the same letter(s) with a treatment are not significantly difference at 5% level of probability using DMRT.

* Significant at 5% level. ** significant at 1% level.

NS = Not Significant WAS = Weeks after Sowing.

for 3 WAS only in 1994 as well as infestation for up to 6 WAS in 1995 produced plants of similar heights to the tallest obtained from plots kept weed-free throughout the growing periods, but taller than the least obtained from the plots weed-infested throughout.

4.3.2 Plant dry weight of maize

Nitrogen application significantly increased plant dry weight of maize in both years. In 1995, plant dry weight increased significantly with nitrogen application of up to 120kg N/ha, (Table 14).

The effect of period of weed interference on plant dry weight was significant in both years (Table 14). In 1994, plots kept weed-free initially for 6 WAS and more and those weed-infested initially for 3 WAS only had similar plant dry weight that were significantly higher than those of other weed interference periods. Similarly, in 1995, plots kept weed-free for 9 WAS and more and those weed infested for 3 and 6 WAS had similar plant dry weight that were higher than those of other weed interference periods.

The interaction of nitrogen and period of weed interference on plant dry weight was significant in 1995 (Table 15). Plant dry weight on the plots kept weed infested for initial 9 WAS increased significanly with nitrogen application upto 120kg N/ha. However, on the plots kept weed-

free for 6 and 12 WAS and those weed infested for all the periods produced plant dry weight that were significantly lower at 0 and 60kg N/ha compared with 120kg N/ha.

4.3.3 Number of days to 50% tasseling of maize

Period of weed interference had significant effect on the number of days to 50% tasseling of maize in 1995 only (Table 14). Weed infestation until harvest resulted in more days to 50% tasseling compared with weed infestation for 3 and 6 WAS. However, plots kept weed-free for various periods except 12 WAS resulted in comparable days to 50% tasseling with the maximum obtained.

4.3.4 Leaf area index of maize

Leaf area index was significantly increased by nitrogen application only in 1994 (Table 14). Application of 60 and 120kg N/ha had similar and significantly higher leaf area index than 0kg N/ha.

Similarly, effect of period of weed interference on leaf area index was significant only in 1994 (Table 14). Crops kept weed free initially for 6 WAS and beyond and those weed-infested for 3 WAS had similar leaf area indices that were significantly higher than those of the crops weed infested for 6 WAS and more. Althogh the crop kept weed-free initially for 3 WAS had lower leaf area index than the maximum but higher than those weed-infested throughout.

4.4 Effect of Nitrogen and Period of Weed Interference on Grain Yield, Threshing Percentage, Panicle Number per Square Meter and 1000-grain weight of rice.

4.4.1 Grain yield of rice

Grain yield of rice was significantly increased by nitrogen application in both years (Table 16). Further increase of nitrogen beyond 60kg/ha did not significantly icrease grain yield.

Period of weed interference significantly influenced the grain yield of rice in both years (Table 16). In the two years, crops kept weed-free initially for 3 WAS only produced grain yields comparable to that weed-infested throughout the crop life cycle. In 1994, the yield obtained from the crops kept weed-free initially for 12 WAS was comparable to that of the crops kept weed-free for 9 WAS and weed-infested initially for 3 WAS but significantly higher than those of the plots kept weed- free for 3 and 6 WAS only and those infested for 6 WAS and more. In 1995, grain yield obtained from the crop kept weed-free throughout the growing period was comparable to the highest obtained with that weed-infested initially for 3 WAS only. However, plots weed infested for 6 and 9 WAS had significantly lower grain yield than the highest obtained. Uncontrolled weed growth throughout the crop life-cycle resulted in 98.79% and 98.91% reduction in rice grain yield in 1994 and 1995 respectively compared to the crops kept weed

Table 16: Effect of nitrogen levels and period of weed interference on grain yield, threshing percentage, Panide number per square meter, 1000 - grain weight of rice at Samaru (1994 and 1995 wet season).

Treatments	Grain yield (kg/ha)		Threshing Percentage		Panicle Number/m^2		1000-grain weight (g)	
	1994	1995	1994	1995	1994	1995	1994	1995
Nitrogen levels (kg/ha)(N)								
0	135b	249b	42	50	24c	20b	22.8	22.3
60	226a	454a	36	49	33b	30a	22.7	25.8
120	304a	520a	43	51	46a	33a	20.9	25.1
SE ±	20.4	43.6	2.2	1.2	3.2	1.3	0.5	0.5
Period of weed interference (W)								
Weed free for 3 WAS	10f	42e	29c	59	4c	6e	11.0c	23.3bc
Weed free for 6 WAS	218d	560c	52ab	61	33b	34b	27.3ab	30.7a
Weed free for 9 WAS	300bcd	598bc	47b	57	41ab	36b	25.9b	29.2a
Weed free for 12 WAS	355b	385c	50ab	61	48a	37b	28.9a	29.7a
Weed free Until harvest	499a	732ab	48b	59	48a	47a	27.9ab	30.4a
Weed infested for 3 WAS	322bc	793a	46b	58	45ab	46a	28.2ab	29.9a
Weed infested for 6 WAS	229cd	506c	48b	59	48a	34b	28.7a	28.8a
Weed infested for 9 WAS	102e	194d	52ab	60	43ab	20c	26.6ab	28.9a
Weed infested for 12 WAS	125e	64de	58a	57	35ab	13d	25.9b	17.6c
Weed infested until harvest	6f	8e	22c	55	2c	3e	100c	9.6d
SE ±	32.6	48.1	3.0	2.8	4.2	2.7	0.7	0.8
Interaction (NxW)	*	*	NS	NS	*	NS	NS	NS

In a column of each factor, means followed by the same letter with a treatment are not significantly difference at 5% level of probability using DMRT.
* Significant at 5% level. ** significant at 1% level.
NS = Not Significant
WAS = Weeks after Sowing.

free throughout.

The interaction of nitrogen and period of weed interference on grain yield of rice in both years was significant (Table 17 and 18). In 1994, no significant differences in grain yields among nitrogen rates was obtained on the plots weed-infested for various periods and those kept weed-free for 3 WAS. On the plots kept weed-free for 12 WAS abd until harvest, 120kg N/ha resulted in higher grain yield than 0 and 60kg N/ha which were similar. 60kg N/ha resulted in higher grain yield than 0kg N/ha on the plots kept weed-free for 6 WAS while 60 and 120kg N/ha caused higher yield than no nitrogen on the plots kept weed free for 9 WAS. In 1995, nitrogen application did not have effect on the grain yield of rice on the plots kept weed-free for 3 and 6 WAS and until harvest. Grain yield increased significantly with nitrogen application on the plots weed-infested initially for 3 WAS. However, with infestation initially for 6 WAS, the grain yield obtained from the plots given 60kg N/ha was significantly higher than those of the plots given 0 and 120kg N/ha. Application of 120kg N/ha resulted in higher grain yields than 0 and 60kg N/ha on the plots kept weed-free for 9 WAS while both 60 and 120kg N/ha increased grain yield significantly on plots kept weed-free initially for 12 WAS.

Table 17: Interaction* of nitrogen level and period of weed interference on grain yield of rice at Samaru (1994 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	----------(kg/ha)------		
Weed free for 3 WAS	7i	13i	10i
Weed free for 6 WAS	86gh	350b-e	219d-h
Weed free for 9 WAS	108gh	425bc	367bcd
Weed free for 12 WAS	317c-f	215d-h	533 b
Weed free Until harvest	328c-f	226d-h	933a
Weed infested for 3 WAS	165c-g	401bcd	400bcd
Weed infested for 6 WAS	153fgh	272c-g	263c-g
Weed infested for 9 WAS	91gh	64h	152fgh
Weed infested for 12 WAS	101gh	104gh	169c-h
Weed infested until harvest	4 i	3 i	14 i
SE_a ±		56.6	
SE_b ±		57.4	

*In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.

Table 18: Interaction* of nitrogen level and period of weed interference on grain yield of rice at Samaru (1994 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	----------(kg/ha)------		
Weed free for 3 WAS	104ik	18k	13k
Weed free for 6 WAS	406f-i	591d-g	684b-f
Weed free for 9 WAS	380ghi	494e-h	920b
Weed free for 12 WAS	229hik	763b-e	754b-e
Weed free Until harvest	662c-g	636c-g	900bc
Weed infested for 3 WAS	334ghi	830bcd	1216a
Weed infested for 6 WAS	146ik	882bc	487e-h
Weed infested for 9 WAS	107ik	246hik	231hik
Weed infested for 12 WAS	102hik	92ik	10k
Weed infested until harvest	24 hik	10 k	10 k
SE_a ±		84.4	
SE_b ±		91.2	

*In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a ± = For comparing means with same level(s) of N

SE_b ± = For comparing means of NxW.

4.4.2 Threshing percentage of rice

The threshing percentage of rice was only significantly affected by period of weed interference in 1994 (Table 16). The plot kept weed-free initially for 3 WAS and those weed infested throughout the growing period produced grains with significantly lower threshing percentage than all other weed interference periods.

4.4.3 Panicle number per square meter

Panicle number increased significantly with increase in nitrogen application of up to 120kg N/ha in 1994. However, in 1995, there was no further increase beyond 60kg N/ha (Table 16).

Period of weed interference significantly influence panicle number in both years (Table 16). In 1994, panicle number obtained on plots kept weed free for 9 WAS and more and those weed-infested for 3 to 12 WAS were similar but significantly higher than those obtained from plot kept weed-free initially for 3 WAS and those infested throughout. In 1995, the plots kept weed-free throughout and those weed-infested initially for 3 WAS had similar but significantly higher number of panicles than the other weed interference periods. However, panicle number obtained from the plots kept weed-free for 6, 9 and 12 WAS and those weed-infested for 6 WAS only were significantly higher than those of the plots infested for 9 WAS and more and those kept weed free initially for 3 WAS.

The interaction of nitrogen and period of weed

interference on panicle number per square meter was significant in 1994 only (Table 19). Panicle number obtained from the plots kept weed-free until harvest and those weed-infested for 9 and 12 WAS was only significantly increased by nitrogen application at 120kg N/ha, while 60kg N/ha significantly increased panicle number on plots kept weed-free for 12 WAS and those infested for 6 WAS compared with no nitrogen. Panicle number were not significantly affected by nitrogen application on the plots kept weed-free for 3, 6 and 9 WAS and those weed-infested for 3 WAS and until harvest.

4.4.4 ***Thousand grain weight of rice***

Period of weed interference significantly affected the 1000 grain weight of rice in both years (Table 16). In 1994, crop kept weed-free for 6 WAS and until harvest and those weed-infested for 3, 6 and 9 WAS had comparable 1000-grain weight to the maximum obtained with the crop kept weed-free initially for 12 WAS. In 1995, 1000-grain weight of the crops kept weed-free initially for 6, 9 and 12 WAS and until harvest as well as those infested initially for 3, 6 and 9 WAS were similar and significantly higher than those of the plots kept weed-free initially for 3 WAS, while weed infestation until harvest produced the lowest 1000-grain weight.

Table 19: Interaction* of nitrogen level and period of weed interference on panicle number per square meter at Samaru (1994 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	----------number/m²)------		
Weed free for 3 WAS	3 g	6 g	12 f-g
Weed free for 6 WAS	26def	26def	46b-e
Weed free for 9 WAS	33def	41b-f	50bcd
Weed free for 12 WAS	36def	64ab	44b-e
Weed free Until harvest	26def	42b-e	76a
Weed infested for 3 WAS	40b-f	46b-e	51bcd
Weed infested for 6 WAS	37e-f	61abc	47b-c
Weed infested for 9 WAS	26def	21ef	83a
Weed infested for 12 WAS	17 f	25def	64ab
Weed infested until harvest	6 g	1 g	2 g
SE_a ±		7.8	
SE_b ±		7.5	

*In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.AN001AAV.USSS[Sorry: Run WPS]

4.5 Effect of Nitrogen and Period of Weed Interference on Panicle Length, Number of Filled grains Per Panicle and Percentage Unfilled grains of rice.

4.5.1 Panicle length

Panicle length was significantly affected by period of weed interference in both years (Table 20). In the two years, crops kept weed-free initially for 6 WAS and more and those weed infested for 3 and 6 WAS only produced panicles that were similar and significantly longer than those of crops infested for 9 WAS and more. However, weed infestation throughout produced the shortest panicles in both years, although crop kept weed-free for 3 WAS was comparable in 1994.

The interaction of nitrogen and period of weed interference on panicle length was significant in 1995 only (Table 21). Application of nitrogen did not have significant effect on panicle length on the plots kept weed-free for 6 and 9 WAS and infested for 6 WAS. However, application of 120kg N/ha increased panicle length significantly compared with no nitrogen on the plots kept weed free and weed-infested for 3 WAS and those infested for 9 WAS. 120kg N/ha also increased panicle length significantly compared with 60kg N/ha on the plots kept weed-free for 12 WAS and throghout. Application of 120kg N/ha, and 60kg N/ha and 120kg N/ha depressed panicle length compared with no nitrogen on the plots weed infested for 12 WAS and until harvest, respectively.

Table 20: Effect of nitrogen levels and period of weed interference on grain yield, threshing percentage, panicle number per square meter, 1000-grain weight of rice at Samaru (1994 and 1995 wet season).

Treatments	Panicle length (cm) 1994	Panicle length (cm) 1995	Number of filled grains 1995	% of Unfilled grains 1995
Nitrogen levels (kg/ha)(N)				
0	13.2	16.9	26b	11a
60	15.4	16.6	36a	7b
120	16.2	16.8	38a	9a
SE ±	0.75	0.55	2.4	0.4
Period of weed interference (W)				
Weed free for 3 WAS	4.5d	18.3bc	21c	9cd
Weed free for 6 WAS	19.5ab	19.8ab	53a	9cd
Weed free for 9 WAS	20.6a	20.9a	47ab	5ef
Weed free for 12 WAS	20.7a	19.2ab	49ab	7cde
Weed free Until harvest	20.2ab	20.1ab	44ab	7cde
Weed infested for 3 WAS	20.1ab	20.6ab	49ab	8cd
Weed infested for 6 WAS	18.2b	18.8b	37b	13 b
Weed infested for 9 WAS	13.9c	16.1c	20cd	18a
Weed infested for 12 WAS	15.5c	9.7d	8de	10 c
Weed infested until harvest	3.8d	4.0e	2e	5 ef
SE ±	0.66	0.70	4.4	0.9
Interaction (NxW)	NS	*	NS	**

In a column of each factor, means followed by the same letter(s) with a treatment are not significantly difference at 5% level of probability using DMRT.

* Significant at 5% level. ** significant at 1% level.

NS = Not Significant

WAS = Weeks after Sowing.

Table 21: Interaction* of nitrogen level and period of weed interference on panicle length of rice at Samaru (1994 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	---------- (cm)------		
Weed free for 3 WAS	15.3f-j	19.4b-f	20.3a-e
Weed free for 6 WAS	18.4b-g	19.9b-e	21.0a-d
Weed free for 9 WAS	20.8a-d	20.7a-e	21.5a-d
Weed free for 12 WAS	19.9b-e	16.2e-i	21.6abc
Weed free Until harvest	19.7b-e	18.3c-g	22.3ab
Weed infested for 3 WAS	17.9c-d	20.6a-e	23.3a
Weed infested for 6 WAS	17.6d-h	19.9b-e	18.9b-f
Weed infested for 9 WAS	13.4 ij	16.4e-i	18.5b-f
Weed infested for 12 WAS	14.8g-j	14.3h-j	10.0 k
Weed infested until harvest	12.0 j	10.0 k	0.0 k
SE_a ±		1.21	
SE_b ±		1.27	

*In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.

4.5.2 Number of filled grains per panicle and percentage unfilled grains

These observations were taken only in 1995. Application of nitrogen significantly increased the number of filled grains per panicle. However, the percentage unfilled grains produced at 0 and 120kg N/ha were similar and significantly higher than that obtained at 60kg N/ha (Table 20).

Period of weed interference significantly affected both the number of filled grains per panicle and the percentage unfilled grains (Table 20). Crops kept weed-free initially for 6 WAS and more and those weed-infested for 3 and 6 WAS produced significantly higher number of filled grains than those of other periods of weed interference.

Crops kept weed-infested for 9 WAS produced the highest percentage unfilled grains, while infestation for 6WAS produced unfilled grains that were significantly higher than other weed infestation period. However, plots weed-infested until harvest and those kept weed-free for initial 9 WAS produced the lowest percentage unfilled grains.

The interaction of nitrogen and period of weed interference on percentage unfilled grains was significant (Table 22). The percentage of unfilled grains obtained at 0 and 60kg N/ha on plot kept weed-free initially for 6 WAS and those weed-infested for 9WAS are similar and significantly lower than that obtained at 120kg N/ha. The percentage

Table 22: Interaction* of nitrogen level and period of weed interference on percentage unfilled grains of rice at Samaru (1995 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	---------- (%)------		
Weed free for 3 WAS	7 g-k	7g-k	12c-g
Weed free for 6 WAS	4 i-l	5 i-l	17b
Weed free for 9 WAS	8 f-j	4 i-l	3jkl
Weed free for 12 WAS	12c-g	6i-k	2kl
Weed free Until harvest	9e-i	7 g-k	5i-l
Weed infested for 3 WAS	8f-j	9e-i	7 g-k
Weed infested for 6 WAS	13cde	3jkl	23a
Weed infested for 9 WAS	16bc	16bc	23a
Weed infested for 12 WAS	17b	12c-g	11
Weed infested until harvest	15bcd	2kl	1 1
SE_a ±		1.6	
SE_b ±		1.6	

*In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.

unfilled grains obtained from the plots weed-infested for 12 WAS decreased with increasing nitrogen application, while, there was no significant influence of nitrogen on the percentage unfilled grains on the plots kept weed-free for 3, 9 WAS and until harvest and those weed-infested for 3 WAS. Plot kept weed-free for 12 WAS had similar percentage unfilled grains at 60 and 120kg N/ha but significantly lower than that obtained at 0kg N/ha, while at weed infestation period for 6 WAS, 120kg N/ha had significantly higher percentage unfilled grains per panicle.

4.6 Effect of Nitrogen and Period of Weed Interference on Plant height, Plant dry weight, Number of days to 50% flowering and Leaf area index of rice

4.6.1 Plant height of rice

Rice plants grown under 60 and 120kg N/ha were similar and significantly taller than those under 0kg N/ha in 1994, while in 1995, application of 60kg N/ha produced significantly taller plants than 0 and 120kg N/ha (Table 23).

Effect of period of weed interference on plant height was significant in both years (Table 23). In 1994, plots kept weed free for 6WAS and more and those infested for 3WAS only produced significant taller plants than those of other weed interference periods. Weed infestation for 9 WAS and those throughout the crop life cycle produced significant shorter plants. In 1995, height of plants obtained from plots kept

Table 23: Effect of nitrogen level and period of weed interference on plant height, Plant dry weight, number of days to 50% flowering and leaf area index of rice at Samaru (1994 and 1995 wet season).

Treatments	Plant height (cm)		Plant dry weight (g)		Number of days to 50% flowering		Leaf area index	
	1994	1995	1994	1995	1994	1995	1994	1995
Nitrogen levels (kg/ha) (N)								
0	50b	61b	8c	7	72	66	1.4	0.9b
60	60a	70a	15a	14	71	65	1.6	1.4a
120	64a	62b	23a	13	71	65	1.8	1.6a
SE ±	2.6	1.8	0.7	1.3	0.2	0.2	0.70	0.10
Period of weed interference								
Weed free for 3 WAS	18d	70ab	8b	9cd	71	65a	1.1c	1.4b
Weed free for 6 WAS	79a	73a	22a	15a	71	65a	1.8a	1.5ab
Weed free for 9 WAS	76a	73a	21a	14a	71	65a	1.8a	1.5ab
Weed free for 12 WAS	80a	69ab	23a	15a	71	65a	1.9a	1.6a
Weed free Until harvest	79a	73a	24a	15a	71	65a	1.9a	1.5ab
Weed infested for 3 WAS	75a	74a	26a	13ab	71	65a	1.8a	1.4b
Weed infested for 6 WAS	67b	67ab	18a	13ab	71	65a	1.8a	1.3bc
Weed infested for 9 WAS	60c	65b	10b	10bc	71	65a	1.5b	1.0cd
Weed infested for 12 WAS	66b	36c	8b	5d	71	44b	1.5b	1.1cd
Weed infested until harvest	59c	36c	6c	5d	70	22c	1.1c	0.9d
SE ±	2.1	2.7	2.0	1.2	0.2	0.3	0.07	0.09
Interaction (NxW)	NS	**	NS	**	NS	NS	NS	NS

In a column for each factor, means followed by same letter are not significantly difference at 5% level of probability using DMRT.

* Significant at 5% level. ** significant at 1% level.

NS = Not Significant WAS = Weeks after Sowing.

weed free initially for various periods and those weed infested for 3 and 6 WAS only are similar and significantly taller than the shortest plants obtained from plot weed infested for 12WAS and until harvest.

The interaction between nitrogen and period of weed interference on plant height of rice was significant in 1995 (Table 24). Plant height obtained from plot kept weed for 6, 9 WAS and until harvest and those weed infested for 3 and 9 WAS did not increased significantly with increase application of 60 to 120kg N/ha, however there was significant increased with the application of 0 to 120kg N/ha. No significant increased was recorded with increase application of nitrogen from plot keep weed free for initial 3 and 12 WAS and those weed infested for 6, 12 WAS and until harvest.

4.6.2 **Plant dry weight of rice**

Plant dry weight increased significantly with increase in nitrogen application up to 120kg N/ha in 1994, however in 1995, there was no significant increase beyond 60kgN/ha (Table 23).

The effect of period of weed interference on plant dry weight in both years was significant (Table 23). For the two years, crops kept weed free for various period except initial 3WAS only and those weed infested for 3WAS in 1994 as well as 3 and 6WAS in 1995 had similar and significantly higher plant dry weight than other weed interference period.

Table 24: Interaction* of nitrogen level and period of weed interference on plant height of rice at Samaru (1995 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	----------(cm)------		
Weed free for 3 WAS	67 c-i	71 b-g	74 a-e
Weed free for 6 WAS	64 d-i	77 a-d	79 abc
Weed free for 9 WAS	62 d-i	73 a-e	86 a
Weed free for 12 WAS	63 d-i	70 b-g	75 a-d
Weed free Until harvest	64 d-i	70 b-g	78 abc
Weed infested for 3 WAS	62 d-i	76 a-d	83 ab
Weed infested for 6 WAS	60 e-i	71 b-f	71 b-g
Weed infested for 9 WAS	55 hi	69 c-h	71 b-f
Weed infested for 12 WAS	53 i	56 ghi	30 i
Weed infested until harvest	49 i	56 ghi	34 ii
SE_a ±		4.7	
SE_b ±		4.8	

*In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.

The interaction between nitrogen and period of weed interference on plant dry weight was significant in 1995 (Table 25). Application of 120kg N/ha resulted in significantly higher plant dry weight than no nitrogen application on the plots kept weed-free for 6 and 9 WAS. However, nitrogen application did not have significant effect on plant dry weight on the plots kept weed-free for the other periods and those weed-infested for all the periods.

4.6.3 Number of days to 50% flowering of rice

Nitrogen application did not significantly affect the number of days to 50% flowering of rice, however, the effect of period of weed interference on days to 50% flowering was significant in 1995 only (Table 23). Crops kept weed free for various periods and those weed infested for initial 3 to 9WAS had similar and significant higher number of days to 50% flowering than weed infestation for 12WAS and until harvest.

4.6.4 Leaf area index of rice (LAI)

Leaf area index was significantly affected by nitrogen application in 1995 only (Table 23). Application of 60 and 120kg N/ha produced similar and significant higher LAI than 0kg N/ha.

Table 25: Interaction* of nitrogen level and period of weed interference on Plant dry weight of rice at at Samaru (1995 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	----------(g)------		
Weed free for 3 WAS	6 cde	10 a-e	12 a-e
Weed free for 6 WAS	8 b-e	17 abc	20 a
Weed free for 9 WAS	6 cde	17 abc	19 ab
Weed free for 12 WAS	8 b-e	17 abc	18 ab
Weed free Until harvest	8 b-e	18 ab	19 ab
Weed infested for 3 WAS	7 cde	16 a-d	14 a-d
Weed infested for 6 WAS	8 b-e	16 a-d	15 a-d
Weed infested for 9 WAS	6 cde	11 a-e	12 a-e
Weed infested for 12 WAS	5 de	10 a-e	3 e
Weed infested until harvest	4 de	12 a-e	5 de
SE_a ±		2.3	
SE_b ±		2.2	

*In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.

Period of weed interference significantly influenced LAI in both years (Table 23). In 1994, plots kept weed free initially for 6WAS and more and those weed infested for 3 and 6 WAS had similar and significantly higher LAI than those of other plots. The crops weed infested initially for 9 and 12 WAS only had significantly higher LAI than those infested until harvest and that kept weed free initially for 3WAS. In 1995, LAI were similar for the plots kept weed free for 6 to 12 WAS and significantly higher than that of the plots kept weed free for initial 3 WAS only and those infested for 9 WAS and more. LAI obtained from crops weed infested for 9 and 12WAS was however comparable to the least obtained at weed infestation throughout the crop life cycle.

4.7 Predicted Maize Grain Yields in response to Period of Weed Interference.

Figures 1 and 2 are curves of predicted values of total maize yields in response to period of weed interference for 1994 and 1995 respectively. It was estimated that yield losses of 10%, 20% and 50% were respectively obtained by keeping the crop weed free for 55, 41 and 31 days after sowing (DAS) in 1994 and 62, 56, and 33DAS in 1995. Similarly, yield losses of 50% and 20% were respectively obtained from plots were infested for 60 and 23 DAS in 1994 while 50%, 20% and 10% losses were obtained from weed infestation of 44, 27 and 22 DAS in 1995.

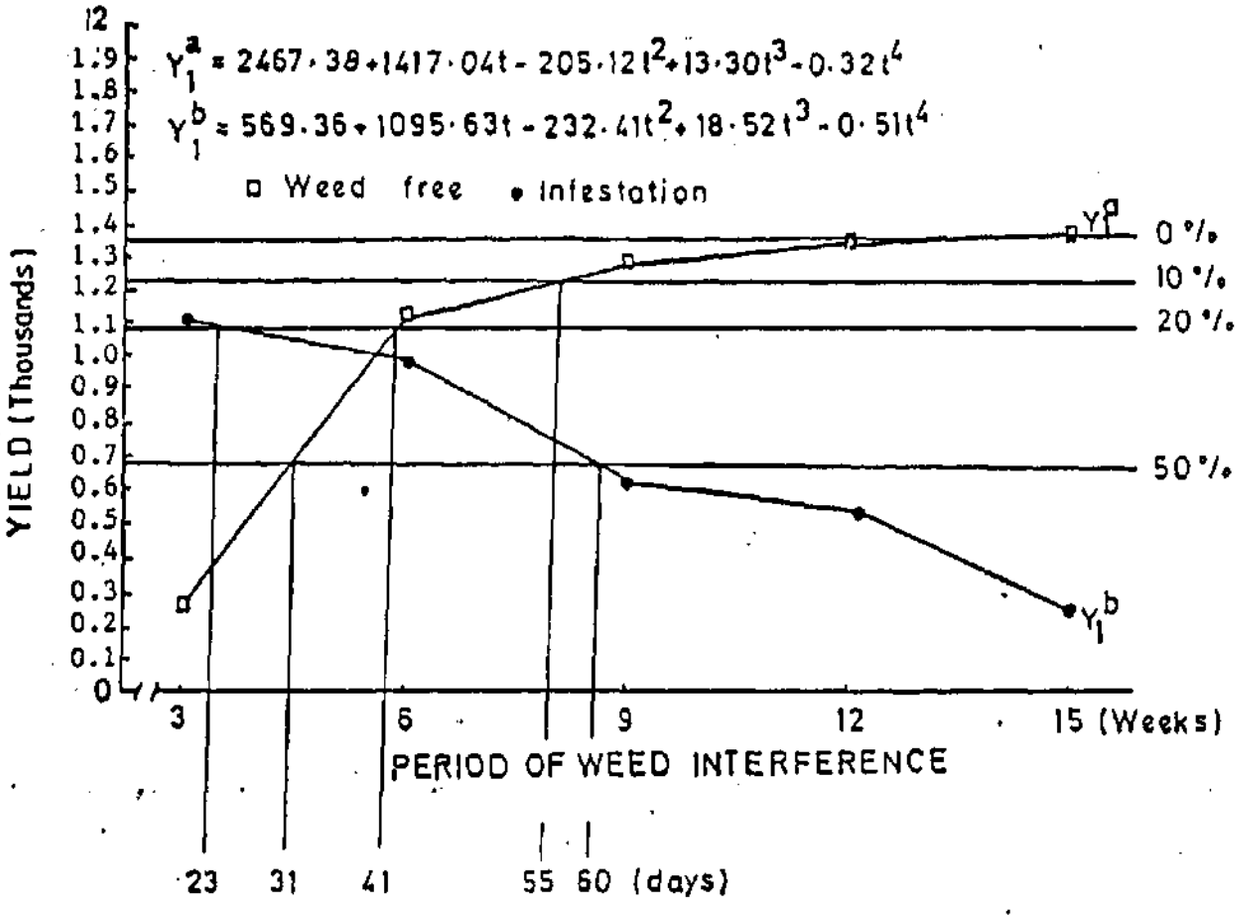


Fig.1: Fitted values of grain yield of maize as affected by period of weed interference in 1994.

$$Y_2^c = 55{\cdot}16 + 422{\cdot}52t + 262{\cdot}44t^2 - 96{\cdot}39t^3 + 0{\cdot}10t^4$$

$$Y_2^d = 952{\cdot}47 + 246{\cdot}94t - 135{\cdot}99t^2 + 14{\cdot}26t^3 - 0{\cdot}45t^4$$

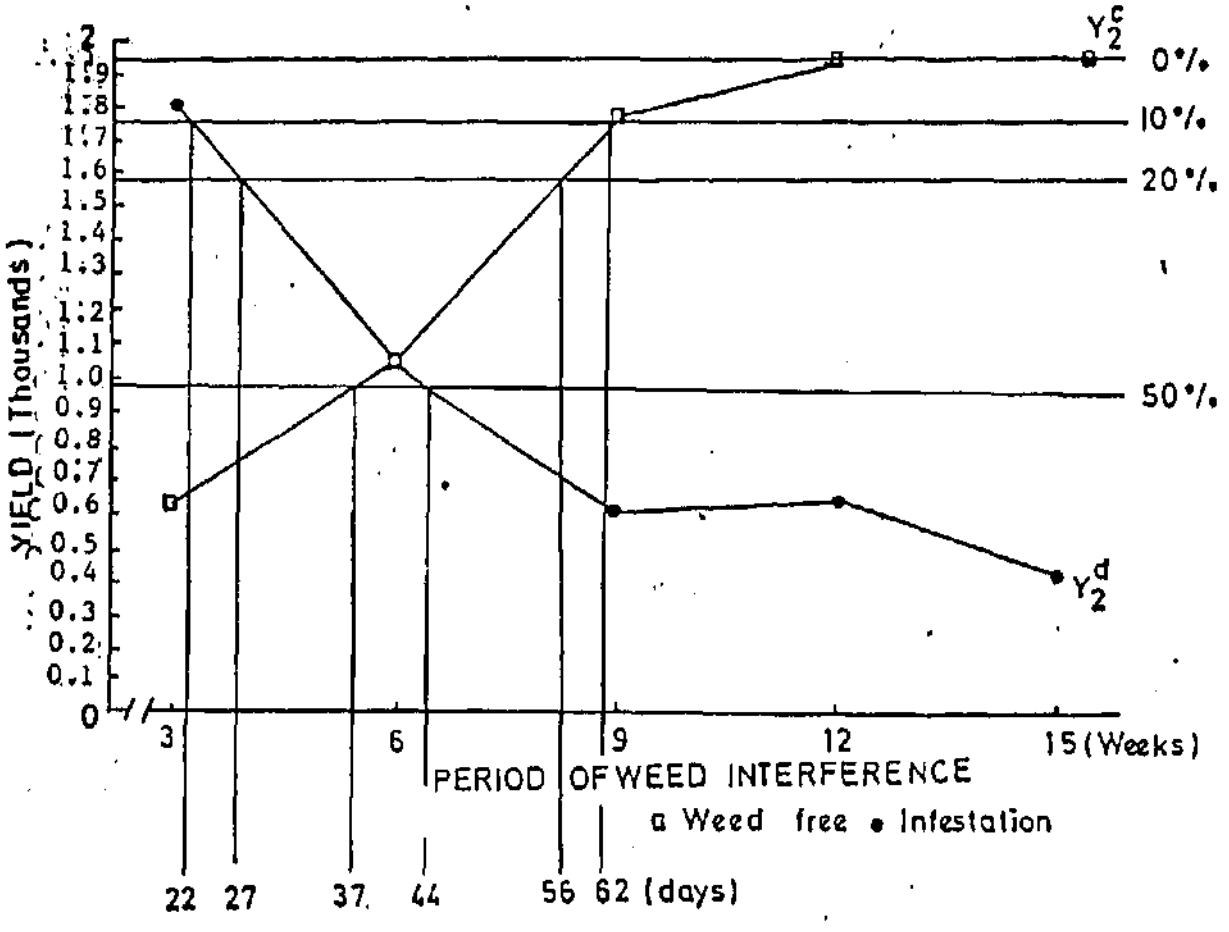


Fig. 2: Fitted values of grain yield of maize as affected by period of weed interference in 1995.

4.8 Predicted Rice Grain Yields in response to Period of Weed Interference

Predicted values of total rice grain yields in response to period of weed interference for 1994 and 1995 are shown in figure 3 and 4 respectively.

It was estimated that yield losses of 10%, 20% and 50% were respectively obtained by keeping the crops weed free for 95, 92 and 63 days after sowing (DAS) in 1994 and loss of 50% by keeping the crops weed free for 36 DAS in 1995. Similarly yield loss of 50% was obtained from plots infested for 43 DAS in 1994 while 50%, 20% and 10% yield losses were respectively obtained for weed infestation of 40, 32 and 22 DAS in 1995.

4.9 Effect of Nitrogen and Period of Weed Interference on Cumulative Weed Dry Matter Production and Weed cover score at maturity.

4.9.1 Cumulative weed dry matter production

Nitrogen application significantly increased cumulative weed dry matter production in both years. In 1995, application of 120kg N/ha, significantly produced higher weed dry matter than 0 and 60kg N/ha (Table 26).

The effect of period of weed interference on cumulative weed dry matter production was significant in both years (Table 26). For the two years, the result for weed dry matter production are similar. Plot weed infested throughout the cropping period produced significantly higher weed dry matter than other periods of weed interference. Similarly, plots kept weed free for 12 WAS and until harvest and those weed infested initially for 3 WAS produced significantly lower weed dry

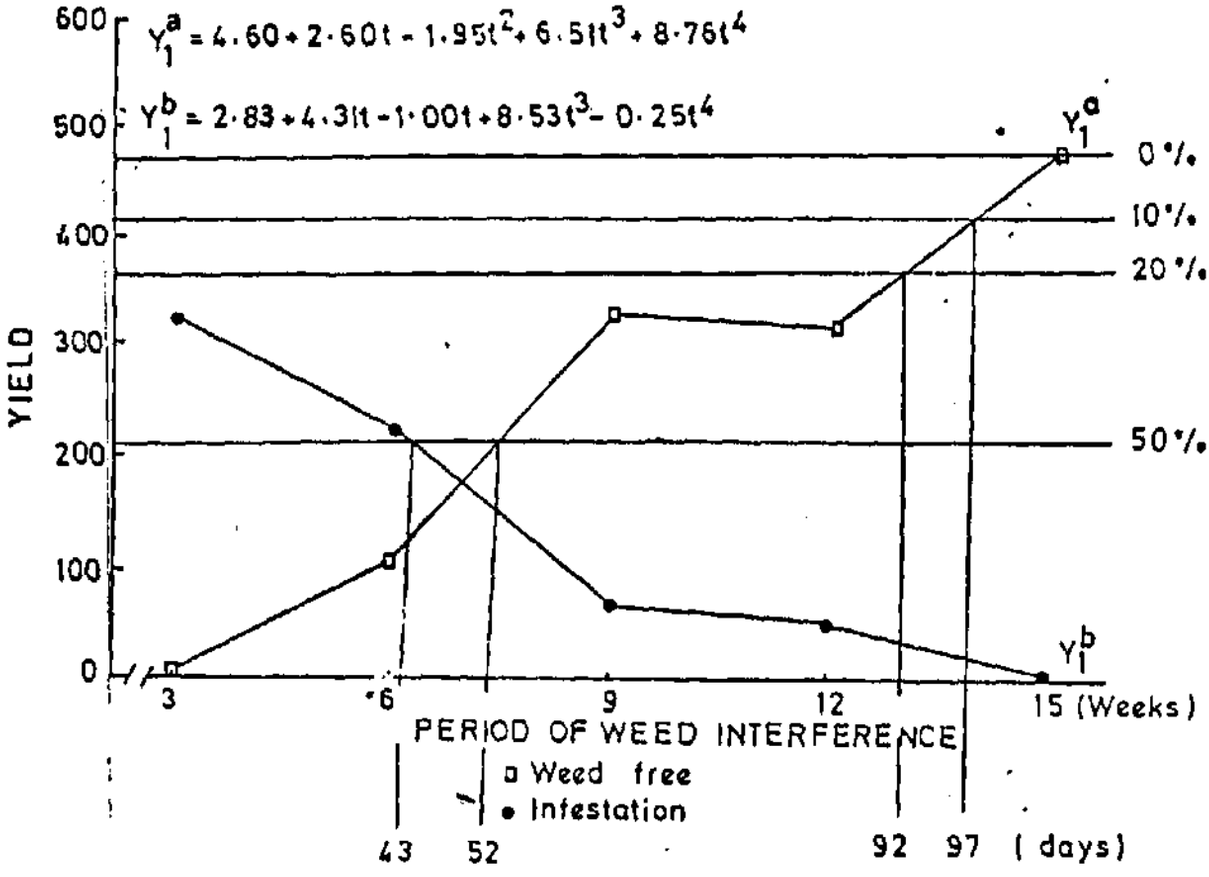


Fig. 3 : Fitted values of grain yield of rice as affected by period of weed interference in 1994.

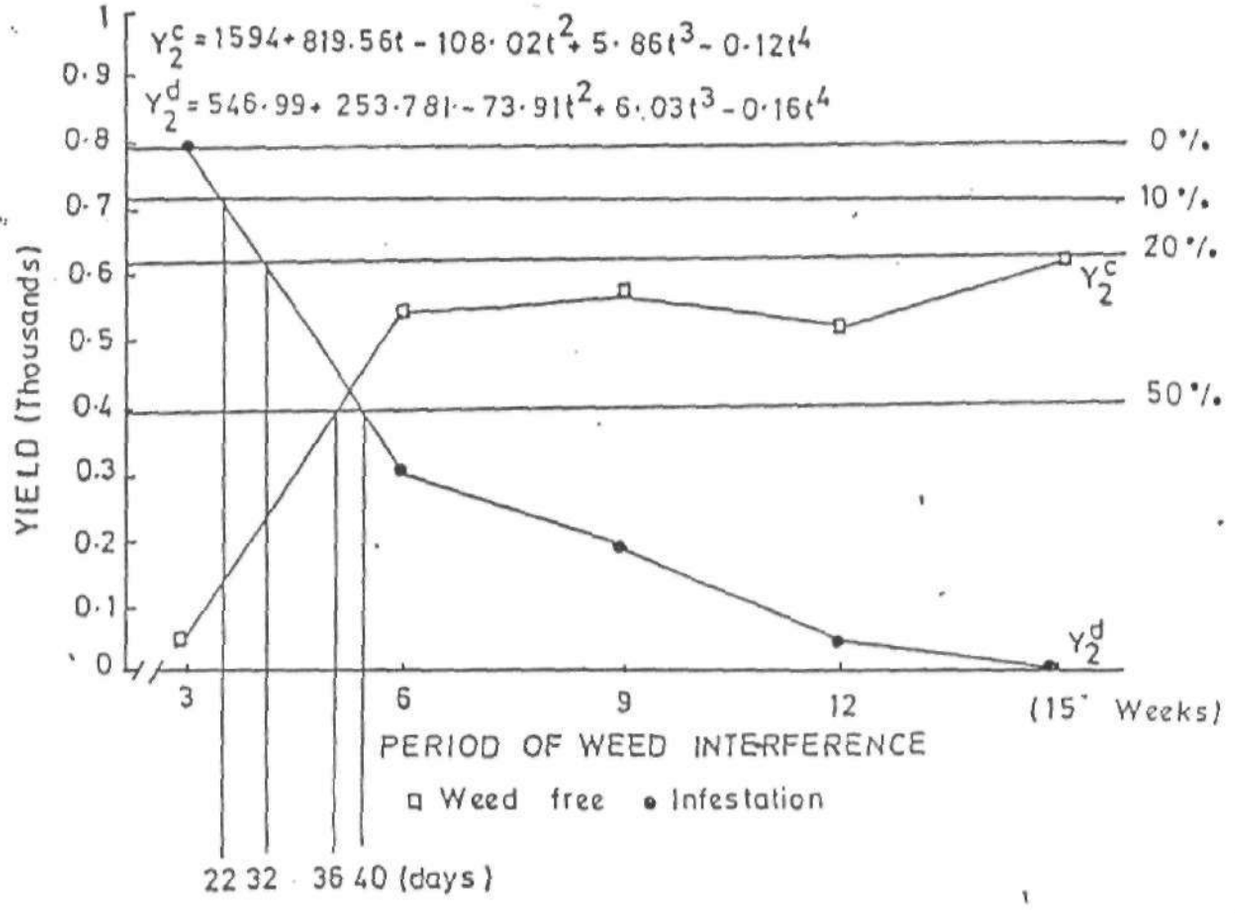


Fig. 4 : Fitted values of grain yield of rice as affected by period of weed interference in 1995.

Table 26: Effect of nitrogen levels and period of weed interference on Cumulative weed dry matter production and weed cover score at Samaru (1994 and 1995 wet season).

	Cumulative weed dry matter (kg/ha)		Weed cover score scale: (0 - 10)	
	1994	1995	1994	1995
Nitrogen levels (kg/ha)(N)				
0	1905b	1623b	3.30	2.83
60	2820a	2312b	3.23	2.90
120	2837a	3206a	3.16	3.43
SE ±	78.6	209.4	0.131	0.219
Period of weed interference (W)				
Weed free for 3 WAS	3308c	3561b	8.11b	6.89b
Weed free for 6 WAS	1847d	2253c	3.67c	3.56c
Weed free for 9 WAS	2015d	1577d	3.00d	2.33 d
Weed free for 12 WAS	724e	817e	1.78e	1.56 e
Weed free Until harvest	806e	599e	1.56ef	1.00f
Weed infested for 3 WAS	702e	902e	1.89e	1.56e
Weed infested for 6 WAS	1866d	2565c	2.00e	2.11de
Weed infested for 9 WAS	3678c	3452b	1.78e	1.89de
Weed infested for 12 WAS	4694b	3673b	1.11f	1.11f
Weed infested until harvest	5566a	4404a	8.89a	8.56a
SE ±	222.8	224.8	1.180	0.194
Interaction (NxW)	**	**	NS	NS

In a column of each factor, means followed by the same letter with a treatment are not significantly difference at 5% level of probability using DMRT.

* Significant at 5% level. ** significant at 1% level.

NS = Not Significant

WAS = Weeks after Sowing.

matter than other weed interference period. Plots kept weed free for 6 and 9 WAS and those weed infested for 6WAS produced significantly lower weed dry matter than those weed free for initial 3 WAS and infestation for 9 and 12 WAS.

The interaction of nitrogen and period of weed interference on cumulative weed dry matter production was significant in both years (Table 27 and 28). In 1994, plots kept weed free for 3 WAS to harvest and those weed infested for 3 and 9 WAS produced weed dry matter that were not significantly increased by increase application of nitrogen. However, plot weed infested for the initial 6 WAS produced significantly higher weed dry matter at 120kg N/ha than 0kg N/ha, while weed dry matter production increased significantly with increase application up to 60kg N/ha from plots weed infested for 12 WAS and until harvest. In 1995, plot kept weed free for 3 to 12 WAS and those weed infested for 6 WAS did not increase significantly in weed dry matter production with increasing nitrogen application, while plots infested for 9 and 12 WAS increased significantly in weed dry matter with up to 60kg/ha application of nitrogen. However, plot kept weed free for 9 WAS and until harvest and those weed infested for 3 WAS and until harvest did not increase significantly in weed

Table 27: Interaction* of nitrogen level and period of weed interference on Cumulative weed dry matter production at Samaru (1994 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	----------(kg/ha) (N)--		
Weed free for 3 WAS	3054 e-h	3462 d-g	3408 d-g
Weed free for 6 WAS	1218 j-m	2320 g-j	2004 h-k
Weed free for 9 WAS	1705 i-m	1875 h-i	2466 g-i
Weed free for 12 WAS	626 lm	539 m	1006 k-m
Weed free Until harvest	590 m	1090 k-m	740 lm
Weed infested for 3 WAS	497 m	901 k-m	707 lm
Weed infested for 6 WAS	1127 j-m	1868 h-l	2604 f-i
Weed infested for 9 WAS	3266 d-g	3995 de	3773 d-f
Weed infested for 12 WAS	2525 g-i	5488 bc	6069 ab
Weed infested until harvest	4437 cd	6666 a	5594 ab
SE_a ±		391.4	
SE_b ±		373.7	

*In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.

Table 28: Interaction* of nitrogen level and period of weed interference on Cumulative weed dry matter production at Samaru (1995 wet season).

Period of Weed Interference (W)	Nitrogen level (Kg/ha) (N) 0	60	120
	---------- kg/ha -----		
Weed free for 3 WAS	2759 d-g	3609 bcd	4317 d-g
Weed free for 6 WAS	1441 h-k	2283 e-i	3035 h-k
Weed free for 9 WAS	1178 ijk	1854 f-j	1698 g-i
Weed free for 12 WAS	687 jk	724 jk	1039 k-m
Weed free Until harvest	508 k	511 jk	720 lm
Weed infested for 3 WAS	706 jk	857 jk	1144 lm
Weed infested for 6 WAS	1602 g-k	2194 e-i	3899 f-i
Weed infested for 9 WAS	1383 h-k	3030 c-f	5943 d-f
Weed infested for 12 WAS	2633 d-h	4143 bc	4243 bc
Weed infested until harvest	3334 b-e	3858 bcd	6021 a
SE_a ±		430.8	
SE_b ±		424.4	

*In both column and row, means followed by the same letter are not significantly different at 5% of probability using DMRT.

WAS = Weeks after Sowing.

SE_a± = For comparing means with same level(s) of N

SE_b± = For comparing means of NxW.

dry matter with application of 0 to 60kg N/ha but further increased of up to 120kg N/ha significantly increased weed dry matter production.

4.9.2 **Weed Cover Score**

Weed cover decreased with increase in weed free period in both years (Table 26). Plot weed infested until harvest produced significant higher weed cover than other period of weed interference. However, plots kept weed free for 12WAS and those weed infested for 3 to 9WAS had comparable and significantly higher weed cover than that kept weed free until harvest and weed infestation for 12WAS. Plots kept weed free for 9WAS produced significant lower weed cover than those weed free for 3 and 6WAS.

4.9.3 **Predicted Weed Dry Matter Production in response to Period of Weed Interference.**

Predicted values for weed dry matter production for 1994 and 1995 is shown in figures 5 and 6 respectively. To obtained 80% reduction in weed dry matter production during the 1994 and 1995 wet season, it was required to keep plots weed free for 78 and 82 DAS respectively. Corresponding weed infestation periods for 1994 is 29 DAS while that of 1995 is less than 21 DAS.

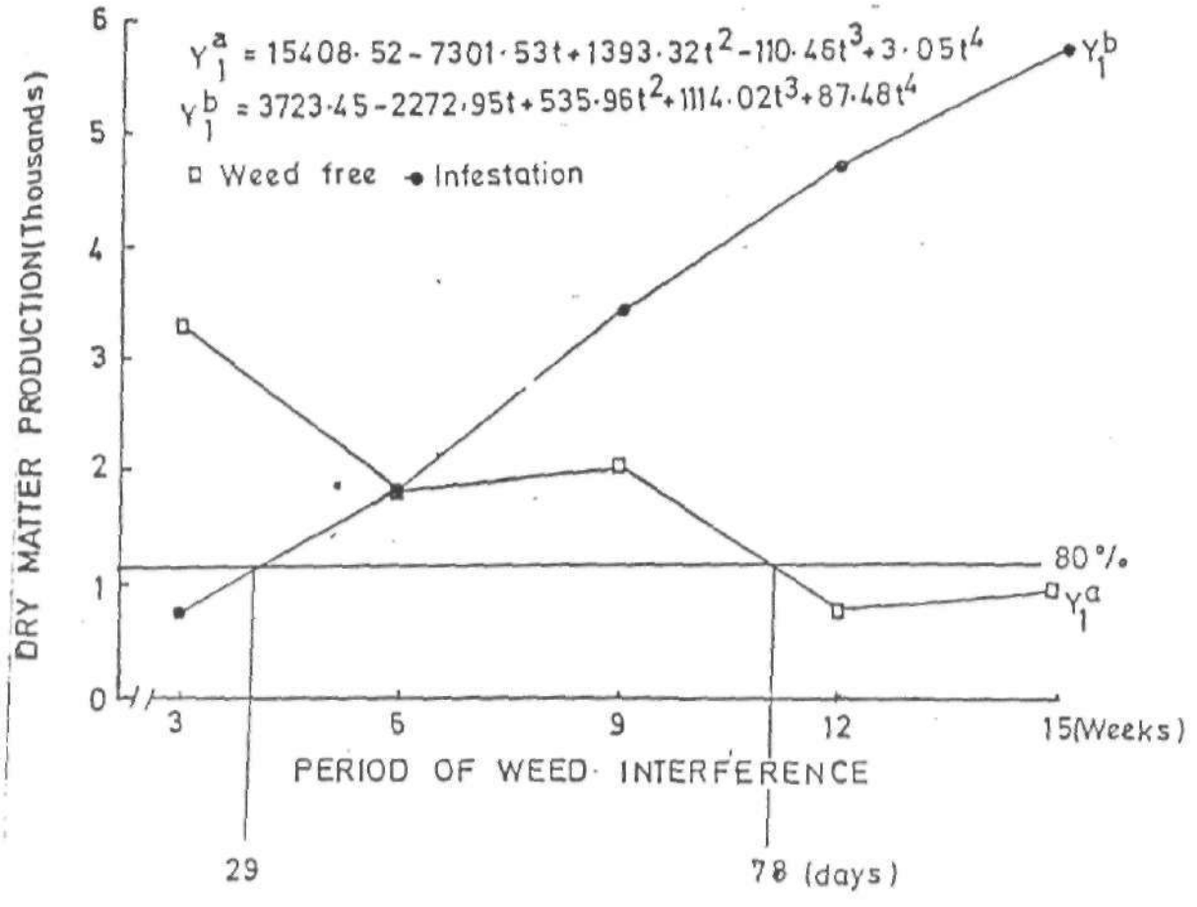


Fig.5. Fitted values of weed dry matter production as affected by period of weed interference in 1994.

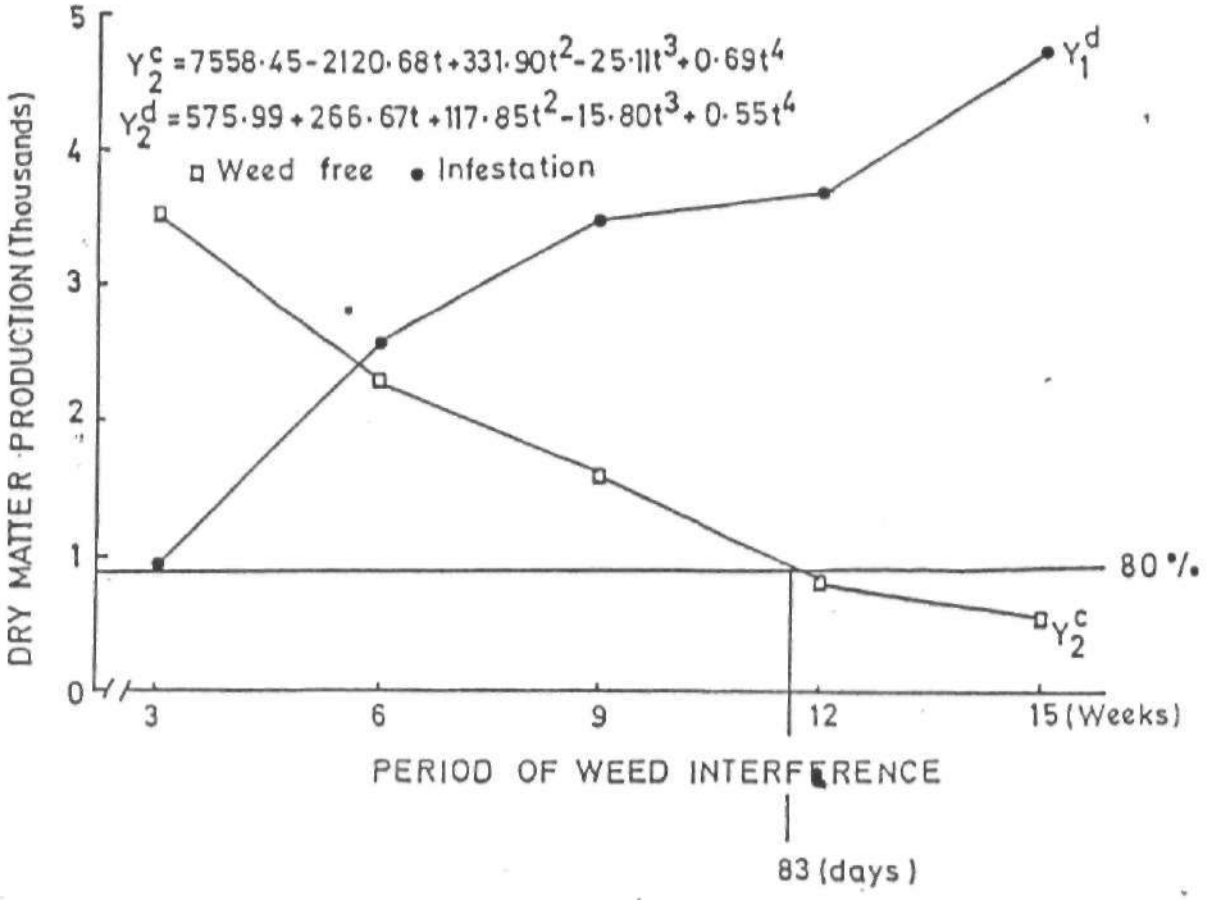


Fig. 6: Fitted values of weed dry matter production as affected by period of weed interference in 1995.

4.10 Correlation among Various Parameters and Grain Yield of Maize and Rice.

The correlation among various parameters and maize grain yield in both years is shown in Table 29 and 30, while that of rice is on Table 31 and 32.

The result of correlation studies revealed that there was positive and highly significant correlation between the grain yield of these crops with other plant characters such as plant heights, plant dry weight, leaf area index, number of cobs/panicle per square meter, 100 and 1000 grain weight for maize and rice respectively. Other character positively correlated with grain yield include cob length, cob diameter, kernel depth, number of grains per panicle and panicle length of rice. However, plant characters such as percentage unfilled grains of rice was not significantly correlated with the grain yield. Number of days to 50% flowering in maize and rice as well as weed characters such as the cumulative weed dry matter production and weed cover score were negatively correlated with the grain yield of maize and rice.

Table 29: Correlation among maize and weed parameter at Samaru (1994 wet season)

	A	B	C	D	E	F	G	H	I	J	K	L	M
A	1.000												
B	0.755**	1.000											
C	0.562**	0.683**	1.000										
D	0.517**	0.600**	0.593**	1.000									
E	0.735**	0.708**	0.463**	0.467**	1.000								
F	0.633**	0.596**	0.545**	0.532**	0.607**	1.000							
G	0.734**	0.687**	0.722**	0.605**	0.694**	0.785**	1.000						
H	0.698**	0.734**	0.714**	0.660**	0.706**	0.819**	0.911**	1.000					
I	0.142	-0.208	-0.098	-0.126	-0.331**	-0.281*	-0.200	-0.298**	1.000				
J	0.592**	0.674**	0.355**	0.436**	0.747**	0.529**	0.607**	0.667	-0.673**	1.000			
K	0.787**	0.712**	0.481**	0.397**	0.815**	0.653**	0.748**	0.739	-0.335**	0.696**	1.000		
L	-0.287	-0.201	-0.244	-0.121	-0.235	-0.227	-0.300**	-0.283	0.056	0.708	-0.315**	1.000	
M	-0.328	-0.201	-0.448	-0.188	-0.110	-0.245*	-0.327**	-0.316	0.059	-0.053	-0.182**	0.486**	1.000

A. Grain yield; B. Number of cobs/m^2; C. 100 grain weight; D. Shelling percentage; E LAI at mmaturity; F Kernel depth; G cob length; H. cob diameter; I Days to 50% tasseling; J Plant height at maturity; K Plant weight; L. Cumulative weed dry matter; M. Weed cover score at harvest * significant at 5% level ** significant at 1% level

Table 30: Correlation among maize and weed parameter at Samaru (1995 wet season)

	A	B	C	D	E	F	G	H	I	J	K	L	M
A	1.000												
B	0.415**	1.000											
C	0.493**	0.415**	1.000										
D	0.498**	0.508**	0.793**	1.000									
E	0.554**	0.353**	0.405**	0.420**	1.000								
F	0.441**	0.337**	0.522**	0.509**	0.428**	1.000							
G	0.551**	0.352**	0.550**	0.560**	0.513**	0.812**	1.000						
H	0.438**	0.309**	0.542**	0.512**	0.487**	0.853**	0.841**	1.000					
I	-0.513**	-0.452**	-0.498**	-0.489**	-0.292**	-0.410**	-0.367**	-0.314**	1.000				
J	0.641**	0.512**	0.733**	0.681**	0.496**	0.646**	0.677**	0.607	-0.518**	1.000			
K	0.726**	0.333**	0.516**	0.480**	0.429**	0.440**	0.559**	0.441	-0.322**	0.615**	1.000		
L	-0.202	-0.117	-0.009	-0.050	-0.002	-0.126	-0.145	-0.120	0.093	0.028	-0.520**	1.000	
M	0.209	-0.142	-0.110	-0.199	-0.257*	-0.184	-0.155	-0.195	0.187	-0.086	-0.435**	0.537**	1.00

A. Grain yield; B. Number of cobs/m^2; C. 100 grain weight; D. Shelling percentage; E LAI at mmaturity; F Kernel depth; G cob length; H. cob diameter; I Days to 50% tasseling; J Plant height at maturity; K Plant weight; L. Cumulative weed dry matter; M. Weed cover score at harvest * significant at 5% level ** significant at 1% level

Table 31: Correlation among rice and weed parameter at Samaru (1994 wet season)

	A	B	C	D	E	F	G	H	I	J	K
A	1.000										
B	0.566**	1.000									
C	0.511**	0.638**	1.000								
D	0.412**	0.542**	0.829**	1.000							
E	0.661**	0.642**	0.847**	0.702**	1.000						
F	0.656**	0.703**	0.903**	0.770**	0.936**	1.000					
G	0.741**	0.597**	0.520**	0.452**	0.733**	0.268**	1.000				
H	-0.507**	-0.349**	-0.555**	-0.397**	-0.596**	0.312	-0.483**	1.000			
I	-0.470**	-0.640**	-0.918**	-0.839**	-0.774**	0.719	-0.453**	0.486**	1.000		
J	-0.202	-0.117	-0.009	-0.050	-0.002	-0.120	0.093	0.028	-0.520**	1.000	
K	0.209	-0.142	-0.110	-0.199	-0.257*	-0.195	0.187	-0.086	-0.435**	0.537**	1.000

A. Grain yield; B. Number of panicles/m^2; C. 1000 grain weight; D. Threshing percentage; E LAI at mmaturity; F. panicle length; G Days to 50% flowering; H Plant height at maturity; I Plant weight; J. Cumulative weed dry matter; K. Weed cover score at harvest * significant at 5% level ** significant at 1% level

Table 32: Correlation among rice and weed parameter at Samaru (1995 wet season)

	A	B	C	D	E	F	G	H	I	J	K	L	M
A	1.000												
B	0.828**	1.000											
C	0.475**	0.531**	1.000										
D	0.273**	0.401**	0.803**	1.000									
E	0.745**	0.661**	0.529**	0.379**	1.000								
F	-0.180**	-0.019**	-0.384**	-0.542**	-0.063**	1.000							
G	0.587**	0.607**	0.812**	0.751**	0.641**	0.242*	1.000						
H	0.362**	0.462**	0.946**	0.869**	0.477**	0.455**	0.863**	1.000					
I	0.441**	0.375**	0.131**	0.038**	0.492**	-0.104**	0.308**	0.073**	1.000				
J	0.535**	0.549*	0.678**	0.583**	0.588**	0.183**	0.763**	0.682	0.342**	1.000			
K	0.629**	0.634**	0.413**	0.312**	0.579**	-0.047**	0.578**	0.377	0.440**	0.652**	1.000		
L	-0.523	-0.477**	-0.560**	-0.287**	0.516	-0.162**	-0.520**	-0.469	-0.141	-0.391	-0.281**	1.000	
M	-0.463**	-0.538**	-0.474**	-0.411**	-0.395	-0.164	-0.435**	-0.433**	0.128	-0.214*	-0.214*	0.537**	1.000

A. Grain yield; B. Number of panicles/m^2; C. 1000 grain weight; D. Threshing percentage; E LAI at maturity; F Percentage unfilled grains; G Number of panicles; H. Panicles length; I Days to 50% flowering; J Plant height at maturity; K Plant weight; L. Cumulative weed dry matter; M. Weed cover score at harvest * significant at 5% level ** significant at 1% level

CHAPTER FIVE

5. DISCUSSION

5.1 Effect of Nitrogen and Period of Weed Interference on the Productivity of Maize in maize/ rice mixture.

Increasing application of nitrogen fertilizer up to 120kg N/ha significantly increased maize grain yield in the mixture. Other plant characters such as plant height , plant dry weight, leaf area index, cob length, kernel depth, cob number per square meter, shelling percentage and 100 grain weight of maize also significantly responded to nitrogen application. The response of these characters to nitrogen application may be due to the fact that nitrogen was known to be the most essential element for plant growth and development (Brady, 1974). This observation agrees with the findings of Ogunlela *et al.* (1988), Jehan *et al.* (1988) and Kombiok (1993) who reported increase in growth, yield and yield components of maize with increasing application of nitrogen. The number of days to 50% tasseling was not significantly affected by nitrogen application in both years which implies that nitrogen does not hasten or delay the tasseling of maize. this observation is in agreement with the findings of Ologunde (1974) who reported that the number of day to 50% tasseling of maize was not significantly affected by nitrogen application

Nitrogen application up to 60kg N/ha did not significantly increas grain yield of maize when plots were weed infested for 9 and 12 WAS. However, further increase of nitrogen to 120kg N/ha significantly increased the grain yield. This implies that higher rate of nitrogen is required to alleviate the yield when plots were kept weedy for up to 9 WAS. Weed

infestation throughout the crop life cycle and weed removal for just the initial 3 WAS did not increased grain yield with increasing application of nitrogen. This observation agrees with the findings of Fagade (1979) who reported lack of response to nitrogen application in the presence of weeds. However. with weed removal until 6, 9, 12WAS and harvest and initial weed infestation for 3 WAS, grain yield significantly increased with increasing nitrogen application. This observation agrees with Kumar and Singh (1985) who reported increase in grain yield with increasing nitrogen application and weed control. In this study, the critical period of weed interference in maize was observed to be between 6 and 9 WAS. This corroborates the findings of Akobundu (1980) who reported 6 to 8 WAS as the critical period of weed interference in maize.

Positive and highly significant correlation observed between maize grain yield with plant characters such as plant height, plant dry weight, leaf area index, cob length,kernel depth, number of cobs per square meter, and 100 grain weight are indication of their strong association.

Negative and highly significant correlation observed between the grain yield with weed dry matter production and weed cover may be due to severe competition exhibited by weed plants with maize for nutrient, space and light as demonstrated in the reduction of grain yield and other yield attributes.

5.2 Effect of Nitrogen and Period of Weed Interference on the Productivity of Rice in maize /rice mixture.

Grain yield of rice in the mixture increased significantly with increased application of up to 60kg N/ha only. This indcates that rice requires less nitrogen than maize for growth and development. The responses of plant characters such as plant height, Plant dry weight, leaf area index and yield components such as number of panicle per square meter, number of filled grains per panicle and percentage unfilled grains is due to the fact that nitrogen is most essental element for plant growth and development (Brady, 1974).

Application of nitrogen did not affect the grain yield of rice when kept weedy for 3 WAS and more in 1994 and 9 WAS and more in 1995. This showed that weeds compete more favourably for the apply nitrogen than rice crop and this result is refelected in increased weed dry matter production in weedy plot when higher dose of nitrogen was applied. This result also further comfirm the findings of Fagade (1979) who reported lack of response to nitrogen application in the presence of weeds. Uuncontrolled weed growth throughout the crop life cycle in both years resulted in higher yield loss than maize (98.85%). This observation conformed with findings of Imeokpharia (1989) and Akobundu (1987) who reported 80 - 100% yield loss in rice due to uncontrolled weed growth.

Plots kept weed free from 6 WAS to harvest in 1994, and 9 and 12 WAS in 1995 resulted in increase grain yield with increasing nitrogen application. This indicate that to increase grain yield of rice, crops are required to be kept weed free for at least 6 WAS. However with infestation for 3 and 6 WAS only in 1995, grain yield increased with increase in nitrogen application. This implies that weed competition with crop is more severe with weed infestation for more than initial 6 WAS. This is because at early period of crop establishment, growth factors are not yet limiting and couple with the low weed densities as observed in weed dry matter production, no adverse effect on crop yield could be recorded. However, as weeds and crops increases, there demand on limited environmental resources increased and competition set in (Akobundu, 1987).

The critical period of weed interference in rice was observed to be between 5 and 9 WAS. This observation conformed with the findings of Lagoke (Unpublished) who reported 6 and 8 weeks after emergence as the critical period of weed competition in rice.

Positive and highly significant correlation observed between the grain yield of rice with yield characters such as panicle number per square meter, panicle length, number of filled grains per panicle and 1000 grain weight is an indication that these characters determines the yield.

Also negative and high significant correlation observed between grain yield of rice with percentage on field grains, weed dry matter production and weed cover indicates that an increase in each of these characters will lead to decrease in the total grain yield of rice.

CHAPTER SIX

6 SUMMARY AND CONCLUSION

A field experiment was conducted during 1994 and 1995 wet season on the research farm of the Institute for Agricultural Research Samaru (11°11'N,07°E 680m)located in northern guinea savanna ecological zone of Nigeria. The main objective was to investigate the effect of nitrogen level and period of weed interference on maize/rice mixture. The treatments consisted of three levels of nitrogen (0, 60 and 120kg/ha) and ten level periods of weed interference (weed free for 3, 6, 9, 12 WAS and harvest and weed infested for the same period). The treatment were laid out in a split plot design with nitrogen in the main plot and period of weed interference in the sub plots.

The varieties of maize and rice used were TZBSR-W(late maturing, streak resistant with white grains) and ITA 257 (early maturing, blast resistant and low shattering) respectively.

The result revealed that increase application of 0 - 120kg N\ha significantly increased grain yield of maize and rice by 92.19% and 53.85% respectively in both years. Other plant characters for maize and rice such as plant height, cob number and panicle number per square meter, shelling percentage, cob length, plant dry weight, leaf area index, 100-grain weight of maize, number of filled grains per panicle and percentage unfilled grains of rice significantly responded to application of nitrogen. However, number of days to 50% flowering in maize and rice, panicle length, threshing percentage and 1000-grain weight of rice was not significantly

affected by nitrogen application both years.

Plot weed infested until harvest and weed removal for the initial 3 WAS did not significantly increase the grain yield of maize with nitrogen application. While in the case of rice weed infestation from 3 WAS to harvest in 1994 and infestation until 9 WAS to harvesting in 1995 and weed removal for the initial 3 WAS in both years were not significantly increased by increase application of nitrogen. However, weed removal until 6, 9,12 WAS and harvest and initial weed infestation for 3WAS increased grain yield of the maize significantly by increasing nitrogen, While weed infestation for 9 and 12 WAS and harvest in 1995 increased significantly with increasing nitrogen application. Uncontrolled weed growth throughout the crop life cycle resulted in 83.03% and 93.85% reduction in average grain yield for both years in maize and rice respectively compared with treatments kept weed free throughout the crop life cycle. The critical period of weed infestation of maize was observed to be between 6 and 9WAS while that of rice was 5 and 9WAS.

Cumulative weed dry matter production and weed cover scores were respectively negatively correlated with the grain yield of maize in 1994 ($r = -0.28$, $r = -0.33$) and 1995 ($r = -0.20$, $r = -0.21$). These characters also correlated negatively with the grain yield of rice respectively in 1994 ($r = -0.20$, $r = -0.21$) and 1995 ($r = -0.32$, $r = -0.46$). While plant characters of maize and rice were highly positively correlated with the grain yields.

In conclusion, nitrogen application of 120kg/ha appears to be the require rate for maize and rice when grown in

mixture, but to obtain optimum yield at this level of nitrogen, the crops are required to be initially kept weed free for up to at least 6WAS and the initial weed infestation should not exceed 3WAS.

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Appendix A: Total rainfall, maximum and minimum temperature, relative humidity at 10 a.m. and 4.00 p.m and sunshine hours at ten days intervals during the period of the experiment at Samaru in 1994.

Months	Days	Total rainfall (mm)	Max. t°c	Min. t°c	Rel. humidity (%) 10.00 a.m.	4.00 p.m
	11-20	88.4	30.4	20.0	78.4	64.0
June	21-30	118.6	30.5	20.2	71.7	55.8
	1-10	53.9	25.8	20.2	85.7	62.0
July	11-20	61.5	29.3	20.4	84.0	57.7
	21-31	53.8	31.5	20.7	91.7	78.6
	1-10	40.6	26.6	20.1	88.7	74.3
August	11-20	62.5	27.4	19.5	82.7	85.5
	21-31	59.3	30.7	19.9	92.2	81.7
	1-10	21.6	28.2	19.4	86.6	69.2
Sept.	11-20	57.5	28.6	19.5	84.1	76.5
	21-30	3.4	27.8	19.6	69.5	77.9
	1-10	26.2	30.1	19.2	78.0	72.9
Oct.	11-20	37.1	30.6	18.6	77.8	67.2
	21-31	5.9	35.2	21.1	81.0	56.7

Source: Samaru meteorological station.

Appendix B: Total rainfall, maximum and minimum temperature, relative humidity at 10.00 a.m. and 4.00 p.m. at ten days intervals during the period of the experiment at Samaru in 1995.

Months	Days	Total rainfall (mm)	Max. t°c	Min. t°c	Rel. humidity (%) 10.00 a.m.	4.00 p.m
	11-20	66.4	32.4	13.9	76.1	45.1
June	21-30	119.6	29.5	18.8	78.6	58.6
	1-10	36.8	28.9	21.8	79.6	59.6
July	11-20	52.3	30.2	22.7	79.4	60.0
	21-31	42.6	36.4	20.7	83.5	81.8
	1-10	88.4	28.7	17.8	84.5	73.9
August	11-20	73.6	29.1	19.5	82.8	73.1
	21-31	96.7	31.3	22.9	86.4	80.3
	1-10	39.3	29.5	21.9	81.9	78.3
Sept.	11-20	80.5	29.4	18.9	81.6	68.7
	21-30	39.3	30.9	20.5	80.5	62.7
	1-10	32.5	31.1	20.1	77.8	74.1
Oct.	11-20	-	32.6	18.7	71.2	44.6
	21-31	-	35.4	20.1	80.6	58.0

Source: Samaru meteorological station.

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