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EFFECTS OF PERIOD OF WEED INTERFERENCE AND CHEMICAL WEED CONTROL ON POT^TO (Solanum tuberosum L.)

BY

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A thesis submitted to the Post-graduate School, Ahmadu Bello University, in partial fulfilment of the requirement for the degree of Master of Science in agronomy

DEPARTMENT OF AGRONOMY
FACULTY OF AGRICULTURE
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NOVEMBER, 1986

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CERTIFICATION

This thesis entitled "EFFECTS OF PERIOD OF WEED INTERFERENCE AND CHEMICAL WEED CONTROL IN POTATO (*Solanum tuberosum* L.)", by Mr. Timothy Ambashak Bulus meets the regulations governing the degree of Master of Science 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 senior brother Mr. Peter R. Ambashak for his endeavours and support in providing me a sound academic footing.

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ABSTRACT

Two field experiments were conducted during the 1985 wet season at Samaru in the northern Guinea savanna ecological zone of Nigeria to study the effect of period of weed interference one evaluate herbicide mixtures for weed control in Irish potato (Solanum tuberosum L.).

The potato varieties B7906-I and Greta were most critically affected by weed interference between 3 and 6 weeks after planting (/AT) and. 6 and 9 weeks after planting (WAP), respectively. Weed infestation for the first 3 weeks after planting did not have any adverse effect on the two potato varieties. However, once infested by weeds until 9 W.AI , subsequent weed removal did not obviate the loss in yield, caused by weed competition with the variety Greta. Keeping B.7906-I and Greta weed-free until 6 and 9 WAP, respectively resulted in yields comparable to the appropriate weed-free controls. It was required to keep variety Greta weed-free throughout its life-cycle and B7906-I weed-free until 50 days after planting in order to obtain maximum tuber yields. As reflected in yields of the crop kept weed-free initially for various periods and those infested for 3 WAP only, it was apparent that with adequate weed central, Greta had higher tuber yield potential than B7906-I.

Among the herbicide mixtures tested on Greta, metolachlor plus metribuzin at 1.00 + 0.25 kg a.i./ha, mixtures of metolachlor with metabromuron and prometryne each at 1.00 + 1.00 and 1.30 + 1.50 kg a.i./ha and ametryne at 1.50 + 1.00 kg a.i./ha combined season-long weed control with high tuber yields, soluble carbohydrate and crude protein that were comparable to those of two and three hoe-weedings.

In the study, weed association with the crop throughout its life-cycle adversely depressed crop vigour, leaf area, leaf area index, tuber soluble carbohydrate end crude protein contents and caused crop yield reduction by about 71.O% And 63.8%, in weed interference and chemical weed control experiments, respectively compared with the appropriate best treatments.

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Chapter 1

INTRODUCTION

Potato (Solanum tuberosum L.) is the most popular tuber food crop of the world (Kay, 1973). A part from its being used for human food, it is also used in agro-industries for the manufacture of Chips, potato flours starch, canned potato and alcohol (Purseglove, 1974; Peter and Su-hua, 1978; Ifenkwe, 1981).

Potato, a new crop to the Nigerian farmers, was introduced to Jos Plateau from the temperate zone by the European miners in the 1920's. The cultivation of the crop is not done on a large scale compared with other root and tuber crops such as cassava, yam and cocoayam in Nigeria (Suchomel and Bot, 1974; Coursey and Booth, 1977). Average tuber yield in Nigeria is 6.2 tonnes per hectare compared with over 30 tonnes per hectare obtained in Europe (Anon., 1981a; Coursey and Booth, 1977; Porter et al., 1983). The low and variable tuber yield obtained in Nigeria have been attributed to a number of reasons which include; (i) the use of low yielding varieties (ii) delayed planting (iii) unsuitable climatic condition (iv) high incidence of diseases and pests especially when planted during the rainy season (v) inadequate cultural practices including low planting density, low fertilizer application and inadequate weed control methods (Mbah, 1985 and Ifenkwe et al., 1986).

Unchecked weed growth with the potato crop throughout its life cycle have been reported to cause between 20 and 81% losses in tuber yield (Harmsworth et al., 1980; Kusome, 1980; Ifenkwe, 1985). The greatest loss in a crop yield due to weed interference occurs during the critical period of weed competition which most workers have reported to be between 3 and 9 weeks after planting. Thus, the determination of the critical period of weed competition helps in estimating the weed control requirement of a crop (Nieto et al., 1968).

The common weed control methods in arable and vegetable crops in Nigeria are hand-pulling of weeds and hoe-weeding. These traditional methods are not only labour demanding, expensive and strenous, but also result in the delay of weeding operations with consequent crop yield losses. In order to reduce yield losses due to weed infestation, an alternative less labour intensive method of weed control is desirable (Sinha et al., 1982).

Herbicides have been reported to reduce labour requirement for manual weeding and crop production and increase profitability compared with the traditional hoe-weeding in both vegetable and arable crops in Nigeria (Lagoke et al., 1981; Sinha et al., 1982; Ogungbile and Lagoke, 1986). However, in potato, little work has been done on the effects of perird of weed

interference and chemical weed control in Nigeria (Ifenkwe, 1985; Nwokocna et al., 1986).

Considering the importance of potato in supplementing food demand and the need to increase its production, this study was initiated with the following objectives:

(i) To study the effects of period of weed interference on potato and determines the critical period of weed competition in the crop.

(ii) To evaluate the performance of some pre-emergence herbicide treatments for weed control in potato.

Chapter 2

REVIEW OF LITERATURE

2.1 Weed Competition in Potato

2.1.1 Losses due to weed competition

The effect of weeds on crop yield varies with the weed species, density and the duration of the crop exposure to weeds (Dowson, 1970; Hewson and Dowson, 1973; Usoroh, 1977). In India, Kirt and Phuranan (1972) and Gupta et al. (1977) reported that early shading of potato plants by weeds was a dominant factor in competition and this reduced tuber yield significantly. In his assessment of the effects of weeds on potato, Fitch (1982) stated that weeds would not only reduce potato yield by competing for nutrients, water, and space, but also serve as hosts for diseases and pests which cause additional tuber yield reduction.

In Michigan, USA, Isleib (1960) observed that quackgrass (Agropyron repens), when allowed to compete with potato throughout its life cycle, reduced tuber yield by 70%. In Canada, quackgrass was also reported to have caused yield reduction of about 52%, when it competed with potato for six weeks after sprouting (Anon., 1981b).

From a survey of 25 states growing about 91% of the potato in U.S.A, Dallyn and Sweet (1970) observed that weeds alone caused a total loss of 65 million dollars

representing an average yield loss of 1.1 tonne/ha. Other investigators have reported 35% to 81% losses in potato yield due to unchecked weed growth throughout the crop life cycle. (Saghir et al., 1974; Mani et al., 1968; Chandra Singh and Rao, 1976).

2.1.2 Differential responses of potato varieties to weed infestation and agronomic practices

Sweet et al. (1973) observed that potato cultivars responded differentially to weed infestation. They noted that potato variety Kotachdrin, the leading commercial variety in U.S.A., was more depressed by weed interference than variety Norchip. In a similar investigation, Ahmed (1980b) used five potato varieties and reported large yield differences due to differences in varietal responses to weed infestation and agronomic practices.

2.1.3 Critical period of weed competition in potato

The critical period of weed competition has been defined as "the period of the crop growth when it is most susceptible to weed competition" (Nieto et al., 1968; Lagoke, 1978; Adigun, 1984). This crop growth period is however influenced by many factors which include relative growth rate of the crop, weed flora, weed species and density, soil moisture and nutrient stress. The concept of critical period of weed competition has practical advantage in defining the

weed control requirements of the crop, especially in chemical and cultural weed control (Adigun, 1984).

Little work has been done to establish the critical period during which weed competition exert a serious effect on the yield of potato. In Lebanon, Saghir et al. (1974) observed that the critical period of weed competition in potato was between 6 and 9 weeks after planting. They further observed that weed infestation until 9 weeks after planting before subsequent removal caused about 31% reduction in potato yield while unchecked weed growth throughout the crop life cycle resulted in about 58% reduction in yield. In Java, Evera'arts et al. (1977) reported that losses due to weed interference amounted to about 28% when potato plants were kept weed-free for the first four weeks after planting and subsequently allowed to be weed-infested till harvest. They however observed that the yield of the treatment did not differ significantly from that of the crop kept weed-free throughout the crop's life cycle.

In India, Singh (1982) also reported that the presence of weeds during the first three weeks after planting did not depress potato yield significantly. He further observed a significant yield depression in plots kept weed-infested until 9 weeks after planting despite subsequent weed removal until harvest.

2.2 Chemical Weed Control in Potato

There is paucity of information on the effect of weeds and their control on the growth and yield of potato in Nigeria (Nwokocha et al., 1983). Nwokocha et al. (1986) have achieved effective weed control with resultant high potato tuber yield after pre-emergence application of metribuzin, metazachlor and mixture of metolachlor plus metobromuron at 0.70 kg a.i./ha, 0.44 kg a.i./ha, and 0.875 + 0.875 kg a.i./ha respectively on Jos Plateau. Mixtures of metribuzin with diphenamid at 0.6 + 4.0 kg a.i./ha and alachlor plus atrazine at 1.34 + 0.58 kg a.i./ha were also reported to combine season-long weed control with high potato yield in the study on Jos Plateau (Nwokocha et al., 1986).

However, in other parts of the world some other herbicides which have been used either singly or in mixture for weed control in potato include the triazines such as ametryne (Edwas, 1971; Alvarez, 1974; Thomas, 1974), atrazine (Spiridonov et al., 1969; Gill et al., 1976), prometryne (Dion, 1974; Feverabend, 1972) and metribuzin (Ramirez et al., 1970), the substituted urea such as metobromuron (Zimdahl, 1971), linuron (Moreland, 1969; Ball, 1970) and a chloroacetamide, metolachlor (Sarpel et al., 1971 and Peak, 1980).

2.2.1 Triazines

Chemically, the triazines are heterocyclic nitrogen derivative. The heterocyclic ring is composed of three nitrogen and three carbon atoms. Triazine herbicides are readily absorbed by roots and translocated via the apoplastic system to the shoots of susceptible plants (Glenn et al., 1975). Several workers have shown that the rate of absorption and translocation of the triazine herbicides from the root to shoot is proportional to the amount of water absorbed and/or the transpiration rate (Wax and Behrens, 1965 and Vostral et al., 1970).

The site of triazine herbicidal action has been reported to be in the chloroplast where Hill reaction of photosynthesis is inhibited. Selectivity is usually based on differential detoxification of the herbicide and induced biological resistance by the plants. Most of the crop plants which tolerate the triazine herbicides rapidly detoxify the triazines by molecular modification of the active molecule to inactive forms (Moreland and Hill, 1962; Gysin and Knusli, 1960).

Ametryne: Ametryne (2- (ethyl amino)-4-(iso-propylamino)-6-methylthio-s-triazine) which has a water solubility of 185 ppm and acute oral LD_{50} of 1110 mg/kg is used as a selective pre-emergence herbicide in many arable crops for the control of annual grasses and broad leaved weeds (Moreland, 1969). It has some foliar activity

and can therefore be applied post-emergence to control weeds (Glenn et al., 1975).

Eddowas (1971) reported that pre-emergence application of ametryne plus monolinuron at the rate of 0.84 + 0.80 kg a.i./ha, in the presence of adequate soil moisture and nutrients, controlled annual weeds effectively in potato. Alvarez (1974) also observed that pre-emergence application of ametryne at 3.0 kg a.i./ha effectively controlled weeds in potato. Thomas (1974) noted that pre-emergence application of ametryne plus metobromuron at 1.5 + 1.75 kg a.i./ha reduced weed infestation substantially without any adverse effect on the potato crop.

Rodriquez et al. (1982) observed that the application of ametryne at 3.2 kg a.i./ha either as pre-emergence or at the germination of 50% potato plants, effectively controlled weeds without any effect on the starch content and weigh of the small-sized potato tubers. They further observed that application of the herbicides at planting gave better results than at seven days after planting.

Atrazine: Atrazine (2-chloro-4(ethylamino)-6-iso propylamine)-s-triazine) is a white crystalline solid with a water solubility of 33 ppm and acute oral LD_{50} of 3080 mg/kg (Glenn et al., 1975). Selectivity of atrazine in higher plants depends on the rate of degradation. Degradation rate is slow in susceptible

plants but rapid in resistant plants (Ashton et al., 1961).

There have been conflicting reports about the ability of atrazine to effectively and selectively control weeds in potato. Spiridonov et al. (1969) achieved about 41% control of broad-leaved weeds in potato with pre-emergence application of atrazine at 1.0 kg a.i./ha. They further indicated that pre-emergence application of atrazine at 2.4 kg a.i./ha followed by supplementary hoe-weeding at 3-leaf stage of plant growth gave about 85% weed control compared with 59% for hand-weeding followed by two interrow cultivations and 48% for plots hand-weeded alone.

Gill et al. (1976) reported effective weed flora reduction in potato when atrazine plus nitrofen at 0.75 + 0.45 kg a.i./ha was applied one day after planting. Similarly, Singh et al. (1970) achieved about 41% control of broadleaved weed in potato when 1.0 kg a.i./ha of atrazine was applied pre-emergence. Srikout et al. (1975) however, observed toxicity on potato plants with the application of atrazine at 0.75 kg a.i./ha.

Metribuzin: Metribuzin (4-amino-6-tert. butyl-3-(methyl thio)-as-triazine-5 (4H) one) is a white crystalline solids which has a water solubility of 1200 ppm and an acute oral LD_{50} of 1937-1986 mg/kg (Glenn et al., 1975). It has a long persistence of more than six months in the soil after application (Fryer and

Makepeace 1977). The pre-emergence application of metribuzin at rates ranging from 0.25 to 1.00 kg a.i./ha have been reported to give effective control of annual grasses and broad-leaved weeds in various crops such as potato, sugar cane, tomatoes, onions and yams (Hilton et al. 1974; Sinha et al., 1982; Sinha and Lagoke, 1983; Lagoke et al., 1983; Tijani, 1985).

Metribuzin has been reported to effectively control weeds on loamy soil at rates between 0.24 and 0.45 kg a.i./ha for early maturing potato varieties, and from 0.50 to 0.70 kg a.i./ha for late maturing varieties (Anon., 1970). Sellock (1978) reported that metribuzin alone at the rate of 1.5 kg a.i./ha resulted in good control of Echinochlea crusgalli weed in potato.

Out of thirteen herbicide treatments tested on potato variety Ultimum, pre-emergence application of metribuzin at 0.75 and 1.0 kg a.i./ha resulted in the best weed control and crop yield. Most weeds that showed reduction in their aerial parts due to the application included Echinochlea crusgalli, Setaria spp. and Digitaria spp. However, 3.0 kg a.i./ha of metribuzin was observed to be toxic to the crop (Rue et al., 1970; Anon., 1974).

Pre-emergence application of metribuzin plus oxadiazon at 1.0 + 2.0 kg a.i./ha was observed to give a season-long weed control in potato (Romero, 1978). Ramirez et al. (1970) however achieved a moderate weed control in potato following post-emergence application of metribuzin plus dalapon at 0.5 + 0.75 kg a.i./ha.

Prometryne: Prometryne (2,4-bis (iso propyl amino)-6-methoxy-s-triazine) is a white crystalline solid with water solubility of 48 ppm and an acute oral LD_{50} of 3750 mg/kg. Reports have shown that prometryne is absorbed by susceptible weeds through both foliage and roots; penetration through leaves appears to be very rapid minimising removal by wind and rains (Glenn et al., 1975).

Both pre-emergence and post-emergence application of prometryne have been shown to selectively control broad-leaved weeds and grasses in cotton, okra, potato, onion, carrot, yam, soybeans, cowpeas and groundnuts (Hilton et al., 1974; Lagoke et al., 1982; Lagoke et al., 1983 ; Lagoke et al., 1986c).

Dion (1974) indicated that the application of prometryne at 1.6 kg a.i./ha either immediately after planting or after earthing up at the beginning of the crop growing period gave effective weed control in potato. Feverabend (1972) also reported good weed flora reduction with a pre-emergence application of prometryne plus simazine at 1.50 + 1.50 kg a.i./ha. Similarly, Veselovskil et al. (1978), using Ukarine potato variety, observed that pre-emergence application of prometryne at 1.5 kg a.i./ha followed by one, two and three inter-row cultivation gave average tuber yield of 22.3, 22.2 and 21.8 t/ha, respectively compared with 18.9 t/ha for prometryne alone.

Pre-emergence application of prometryne at 2.00 kg a.i./ha followed by earthing-up between five and six weeks after planting was reported to result in effective weed control and high tuber yield of potato (Sadunas, 1970). In Cyprus, a mixture of prometryne, metobromuron and linuron at 0.20, 0.15 and 0.15 kg a.i./ha respectively was reported to give a season-long weed control and high tuber yield in autumn potato (Anon., 1970).

2.2.2 Chloro-acetamide herbicides

The chloro-acetamide group constitutes a major subdivision of the amide class of herbicides. The members which include, alachlor, butachlor, metolachlor, propachlor, propanil, have a monochlorinated methyl in the R-1 position (Glenn et al., 1975).

Chloro-acetamides are readily absorbed by susceptible plants, primarily between seed and first node of germinating seedling and appeared to be translocated primarily in apoplast but symplastic movement may also occur. They inhibit mitochondrial phosphorylation and mitotic division. The inhibition increases with increasing concentration and varios with different species. They are primarily effective on grass species although many have activities on broad-leaved weeds and sedges (Ashton et al., 1981).

Metolachlor: Metolachlor (2-chloro-N-(2-ethyl-6-methyl-phenyl)-N-(2-methexyl-1-methylethyl), which is usually formulated as an emulsifiable concentrate, was

reported to be mainly effective against many grasses as a germination inhibitor at rates ranging from 1.0 to 2.5 kg a.i./ha (Gerber et al., 1974). It was further observed that metolachlor was absorbed through the emerging coleoptile, and that its effectiveness was influenced by soil and climatic conditions.

A number of workers have achieved effective weed control, especially grasses, in many field crops such as cowpea, cotton, tomatoes, melon, onion, yam and maize with pre-emergence application of metolachlor either alone or in mixture with other herbicides (Peak, 1980; Lagoke et al., 1981; Lagoke et al., 1982; Lagoke et al., 1986a; Lagoke et al., 1986b).

Sarpel et al. (1971) achieved a desirable control of weeds and high potato yield with pre-emergence application of metolachlor at 3.00 kg a.i./ha. Murphy and Morrow (1979) reported excellent control of weeds including Echinochlea crusgallis, and Chenopodium album, with pre-emergence application of metolachlor on potato at 2.24 to 3.16 kg a.i./ha alone and in mixture with metribuzin at 0.56 kg a.i./ha, linuron at 1.12 kg and dinoseb at 3.36 kg. In the study, no injury was noticed on the potato and yield differences were not significant. The result further indicated that metolachlor could be applied in mixture with several herbicides to achieve a season-long weed reduction in potato.

2.2.3 Substituted urea

The substituted urea herbicides include chlorobromuron, fenuron, diuron, linuron and metobromuron which had mainly soil-residual effect and are absorbed by roots of plants through nutrients and water into the xylem system in which they are transported. The main site of action of this group of herbicides is the interference with photolysis of water during photosynthesis and nitrogen metabolism in susceptible plants (Overbeek, 1964; Ashton et al., 1981).

Linuron: Linuron 3 (3, 4-dichloro phenyl)-1-methylurea) which normally exists as a white crystalline solid with water solubility of 75 ppm and an acute oral LD_{50} of about 1500 mg/kg is mainly formulated as a wettable powder containing 50% active ingredient (Overbeek, 1964). Linuron is a systemic herbicide which is absorbed mainly through the root system and the leaves. The herbicidal activity of this chemical is based on its interference with photosynthesis by inhibiting the Hill reaction (Overbeek, 1964).

Moreland (1969) and Ashton et al. (1981) observed that differential rates of translocation and detoxification of linuron in plants determine its selectivity. The susceptible plants detoxify linuron less readily than resistant plants. In addition, linuron has a low water solubility and hence its movement in the soil is almost negligible. In a mm

application, the active ingredient therefore stays in the upper-most layer of the soil where the majority of annual weeds germinate while the seeds of cultivated plants lie deeper in the soil. This enhances the herbicide effectiveness against susceptible weeds.

Pre-emergence application of linuron in mixture with other herbicides have been reported to enhance its selective weed reduction in many field and vegetable crops such as maize, sorghum, groundnuts, chillis, onions, and tomatoes. (Lagoke et al., 1983; Adigun, 1984; Bakut, 1985; Gworgwor, 1985).

In the United Kingdom, Ball (1970) reported effective weed control in potato when trientazine plus linuron at 2.24 + 2.24 kg a.i./ha was applied both pre-emergence and post-emergence. However, he observed less effectiveness of the herbicide mixture when weeds had passed cotyledonary stage.

Metobromuron: Metobromuron (2-(4-bromophenoly)-1-methoxy-1-methyl urea) has a water solubility of 330 ppm and an acute oral LD_{50} of 3000 mg/kg (Glenn et al., 1975). Metobromuron may be applied pre-emergence alone or in mixture with other herbicides for a season-long control of many annual grasses and certain broad-leaved weeds in crops like potato, maize, sorghum and some solanaceous vegetables (Ashton et al., 1978; Glenn et al., 1975; Usoroh, 1977; Lagoke et al., 1981; Singh et al., 1980

Pre-emergence application of metobromuron alone at 4.0 kg a.i./ha was reported to give a season-long control of weeds in potato (Fricke, 1969). Zimdahl (1971) obtained a significant weed reduction and high potato tuber yield when mixture of metobromuron and chlorobromuron att1.5 + 1.5 kg a.i./ha was applied pre-emergence on a sandy soil, although higher rates were phytotoxic to potato plants.

Dion (1974) achieved a satisfactory weed control and high potato tuber yield when metobromuron at 1.6 kg a.i./ha applied immediately after planting was followed by earthing up between four and five weeks after planting. Metolachlor plus metobromuron at 0.875 + 0.875 kg a.i./ha was also reported to combine selectivity with high tuber yield on Jos Plateau (Nwokocha et al., 1986).

Chapter 3

MATERIALS AND METHODS

3.1 Description of Experimental Site

Two field experiments were conducted on the farm of the Institute for Agricultural Research, Ahmadu Bello University, Samaru ($11^{\circ}11'N$, $07^{\circ}38'E$) in the northern Guinea Savannah ecological zone of Nigeria, during the 1985 wet season, to determine the effect of period of weed interference and evaluate herbicide mixtures for weed control in potato. The two experiments were sited on the same field which had a sandy loam soil, and was previously cropped with soyabean in 1984, after a long fallow period. Details of the physico-chemical composition of the soil at the experimental site are contained in Table 1. A total of 708.8 mm rainfall was received during the crop growing period. Details of the distribution of rainfall, relative humidity, sunshine and temperature at Samaru during the period of the trials are shown in Table 2.

The weeds present at the experimental site included broad-leaved weeds, annual grasses and sedges. Table 3 shows the common weed species observed at the site during the growing season and their levels of infestation.

Table 1: Physico-chemical analysis of soil of the experimental site at Samaru, 1985.

Soil composition	Soil Depth (cm) 0 - 15
Texture %	
Sand	44.67
Silt	42.66
Clay	12.67
Soil textural class	Sandy loam
p.H. in water (1:1)	6.1
Organic carbon, C (%)	0.70
Total nitrogen (%)	0.08
Exchangeable cations (Meq/100 g soil):	
Sodium, Na	0.10
Potassium, K	0.69
Caloium, Ca	2.89
Magnesium, Mg	0.76
Available Phosphorus, P (ppm)	0.63

Table 2: Mean temperature, relative humidity sunshine hours and total rainfall at 10-day interval during the period of the trial in 1985 wet season at Samaru.

Month : days	Total rainfall (mm)	Mean temperature (°C)	Relative humidity (%)	Sun Shine (hours)
May 1 - 10	27.10	30.7	62.4	7.63
11 - 20	14.70	29.6	64.6	7.75
21 - 30	98.90	28.8	79.8	8.64
June 1 - 10	8.5	26.6	71.4	7.99
11 - 20	61.6	26.0	73.6	7.45
21 - 30	72.2	25.4	81.8	7.53
July 1 - 10	143.6	25.0	81.4	6.70
11 - 20	76.2	23.8	91.5	4.47
21 - 30	93.3	26.8	94.7	7.04
August				
1 - 10	95.7	[illegible]	84.7	7.20
11 - 20	93.30	25.3	64.8	7.64
21 - 30	67.60	28.3	87.5	7.48
September				
1 - 10	52.50	25.2	79.8	6.62
11 - 20	76.05	24.7	80.6	7.15
21 - 30	35.40	25.6	72.6	7.82

Source: Meteorological Unit, Institute for Agricultural Research, Samaru, Zaria, Nigeria.

Table 3: List of common weed species at the experimental site, Zaberu, 1985 wet season.

Types of Weeds	Level of Weed Infestation
Annual grasses	
Eleusine indica (L) Gaertn	***
Digitaria horizontalis Willd	**
Panicum maximum Jacos	***
Broad leaved Weeds	
Portulaca oleraceae (L)	***
Vernonia galamensis (Cass) (Less)	***
Ageratum conyzoides (L)	**
Amaranthus viridis (L)	**
Acanthospermun hispidum (Dc)	**
Cassia mimosoides (L)	*
Sedges	
Mariscus alternifolius Vanl	*

* = Low infestation
** = Moderate infestation
*** = Heavy infestation

Table 4: Details of treatments of the weed interference study in potato at Samaru, 1985 wet season.

TREATMENTS
Main treatment (otato varieties)
V_1 = B7906-I
V_2 = Greta
Sub-treatment (Period of weed interference)
Weed-free for the first 3 WAP*
Weed-free for the first 6 WAP*
Weed-free for the first 9 WAP*
Weed-free until harvest
Weed-infested for the first 3 WAP**
Weed-infested for the first 6 WAP**
Weed-infested for the first 9 WAP**
Weed-infested until harvest.

WAP = Weeks after planting.

* = Initially weed-free periods and subsequently

** = Initially weed-infested periods and subsequently kept weed-free until harvest.

Table 5: Details of herbicide treatments in the herbicide evaluation trial in potato at Samaru, 1985 wet season..

TREATMENTS	
Herbicides[1]	Rate kg a.i./ha
Metolachlor + Ametryne	1.00 + 0.75
Metolachlor + Ametryne	1.50 + 1.00
Metolachlor + Atrazine	1.33 + 0.67
Metolachlor + Atrazine	2.00 + 1.00
Metolachlor + Metobromuron	1.00 + 1.00
Metolachlor + Metobromuron	1.50 + 1.50
Metolachlor + Linuron	1.00 + 0.50
Metolachlor + Linuron	1.50 + 0.75
Metolachlor + Prometryne	1.00 + 1.00
Metolachlor + Prometryne	1.50 + 1.50
Metolachlor + Metribuzin	1.00 + 0.35
Metolachlor + Metribuzin	1.50 + 0.50
Hoe-weeding at 3, and 6 weeks after planting.	-
Hoe-weeding at 3, 6, and 9 weeks after planting.	-
Untreated check.	-

[1]All herbicide treatments were applied pre-emergence, a day after planting.

3.2 Treatments and Experimental Design

In the weed interference trial (Experiment I), a factorial combination of two potato varieties B7906-I and Greta, with eight periods of weed interference was adopted (Table 4). The herbicide evaluation trial (Experiment II) consisted of twelve herbicide treatments of six metolachlor-based mixtures, each at two rates, two levels of hoe-weeded control and an untreated check (Table 5). In both experiments, gross and net plot sizes were 10.8 m^2 and 3.6 m^2 respectively, using a randomised complete block design with three replications. The gross plots consisted of six ridges at 75 cm apart and each 240 cm long while the net plot consisted of the two inner ridges of the gross plot.

3.3 Cultural Practices

3.3.1 Land preparation and planting

The site used for the experiments was ploughed and disc-harrowed at two weeks interval. Single super phosphate and muriate of potash were broadcast at the rate of 60 kg P_2O_5/ha and 40 kg K_2O/ha respectively as basal application before ridges were made at 75 cm apart. Calcium ammonium nitrate at the rate of 60 kg N/ha was equally split-applied at planting and as side-dress at four weeks after planting (WAP).

The two trials were established on 12th June 1985 when the rains had stabilised. Potato, varieties B7906-I and Greta, were planted at intra-row spacing of 30 cm for weed interference trial (Table 4), while only Greta was used in herbicide evaluation trial at the same spacing (Table 5). One healthy sprouting potato seed was planted per stand, giving a population of 44,445 stands per hectare in both experiments.

3.3.2 Crop protection

Weeding operations were conducted as shown in Table 4 and 5. Fungicide, Dithane M45 was also sprayed at the rate of 2.5 kg a.i./ha once weekly, commencing at 4½ weeks after planting until 9 weeks after planting to control potato blight caused by Phytophthora infestans.

3.3.3 Harvesting

In both experiments, harvesting was done on 4th September 1985, at 11½ weeks after planting.

3.4 Herbicide Application

All the herbicide mixtures were applied pre-emergence, one day after planting using a knapsack sprayer with a deflector nozxle, at a pressure of about 2.1 kg/cm^2 and a spray volume of about 250 L/ha.

3.5 Data Collection

3.5.1 Weed infestation

Weed cover score: Weed cover score was taken at 6 and 9 weeks after planting and at harvest. A scale of 0 to 10 was used to assess infestation, where 0 represented no weed cover and 10 represented complete weed cover.

Weed dry matter production: Weed samples were taken from two 0.45 sq m quadrats per plot before each weeding was done at 3, 6 and 9 weeks after planting and at harvest. The samples were cleaned free of soil and weighed fresh and oven-dried at 70^{o}C to constant weight for dry matter determination. Cumulative weed dry matter production in the weed interference experiment was determined by adding up weed dry weight at the time of each weeding and at harvest.

3.5.2 Crop growth parameters

Crop establishment: Crop stand count at two weeks after planting and at harvest were taken from the net plot in order to assess the effect of treatments on crop establishment.

Crop Vigour score: At 6 and 9 weeks after planting and at harvest, crop vigour score were taken using a scale of 0 to 10, where 0 represented completely dead plant and 10 represented the most vigorous crop. Parameters taken into consideration in vigour score, included plant height,

number of leaves per plant, leaf spread and greeness.

Leaf area determination: Leaf area was determined by using punch method to remove discs from the leaves as described by Dutsin-Ma (1985), leaf area index, relative growth rate and crop growth rate were estimated using the method described by Watson (1947) at 6 and 9 WAP.

Haulm dry matter production: Stem and leaf samples from two tagged plants per plot were oven-dried for 48 hours at 70°C to constant weights for the determination of haulm dry matter production, at 6, and 9 WAP.

3.5.3 Tuberization and potato yield

Fresh tuber weight and number at 6 and 9 weeks after planting were taken per plant in order to assess the effect of treatments on tuber initiation. The fresh tubers were cleaned and over-dried for 48 hours at 70°C to constant weight to determine tuber dry matter production.

Fresh tuber weight and number per net plot were taken and yield per hectare were subsequently calculated. The result on the number and yield of various sizes of potato tubers viz large (> 4.5 cm), medium (4.4-3.5cm) and small-sized (< 3.5cm) were also recorded. Potato tubers obtained from the herbicide trial were analysed for soluble carbohydrate and crude protein content using the method described by Allen et al. (1974).

3.6 Analysis of Data

All the data collected were subjected to analysis of variance and the treatment means compared using Duncan Multiple Range Test (DMRT) (Duncan, 1955). Correlation coefficient and regression analyses were also done on appropriate parameters (Table 6 to 19).

Chapter 4

RESULTS

4.1 Effect of Period of Weed Interference on Potato Varieties B7906-I and Greta

The effect of period of weed interference on various growth parameters viz. crop stand count, crop vigour score, plant height, leaf number, leaf area, leaf area index, haulm dry matter production, crop growth rate, relative growth rate and yield of the two potato varieties are shown in Table 6 to 11.

4.1.1 Crop stand count

The effects of treatments on crop establishment as reflected in stand count are shown in Table 6. Significant difference in stand count was only observed at two weeks after planting, with variety B7906-I having a higher count than Greta. Neither the effect of period of weed interference nor the interaction with variety on crop establishment was significant.

4.1.2 Crop vigour score

The effects of variety and period of weed interference on crop vigour scores of potato at 6 and 9 weeks after planting and at harvest were significant (Table 6). While B7906-I and more vigourously growing plants at 6 WAP, Greta had significantly higher crop vigour at 9 WAP and at harvest.

Table 6: Effect of period of weed interference on the growth of potato varieties, D7906-I and Greta during the 1985 wet season, at Samaru.

Treatments	Crop vigour score[1]			Crop height (cm)	Number of leaves per plant at	Leaf dry weigh (g)		Crop stand count (%)	
	6 WAP[2]	9 WAP	Harvest	9 WAP	9 WAP	6 WAP	9 WA	per net plot 2 WAP	Harvest
Potato varieties									
D7906-I	6.5[a3]	5.4[b]	5.1[b]	58.8[b]	28.42[b]	6.57[a]	8.81	89.9[a]	91.00
Greta	5.0[b]	6.3[a]	6.0[a]	76.5[a]	42.92[a]	5.51[b]	12.0[a]	81.7[b]	92.20
SE±	0.34	0.22	2.21	3.18	4.72	0.37	0.7	1.93	1.36 NS
Period of weed interference									
Weed-free for 3 WAP	5.9[ab]	5.8[bc]	5.5[cd]	67.3[ab]	37.27[ab]	5.77[ab]	10.02[b]	78.0	89.1
Weed-free for 6 WAP	5.8[ab]	6.1[ab]	5.8[bc]	63.8[ab]	38.0[ab]	6.80[b]	10.33[b]	80.8	89.0
Weed-free for 9 WAP	*	7.3[a]	6.8[a]	74.5[ab]	43.2[a]	*	14.3[a]	87.4	92.2
Weed-free until harvest	*	*	6.5[ab]	*	*	*	*	82.9	99.5
Weed-infested for 3 WAP	6.3[a]	6.0[ab]	5.7[bcd]	75.2[a]	40.7[ab]	6.01[ab]	13.44[ab]	90.1	91.2
Weed-infested for 6 WAP	4.0[b]	5.4[bc]	5.1[cde]	60.5[b]	30.8[ab]	5.13[b]	7.66[c]	89.1	90.1
Weed-infested for 9 WAP	*	4.8[c]	4.7[de]	61.8[ab]	21.3[b]	*	5.33[c]	89.8	90.5
Weed-infested until harvest	*	*	4.3[e]	*	*	*	*	84.4	90.8
SE±	0.67	0.44	0.42	6.36	9.44	0.75	1.53	3.86	2.4 NS
Interaction of varieties and period of weed interference									
SE±	0.95 NS	0.63 NS	0.59 NS	8.99 NS	13.35 NS	1.05 NS	2.16 NS	2.63 NS	1.86 NS

[1]Crop vigour score using scale (0-10); where 0 = completely killed plant and 10 = most vigorous plant.

[2]WAP = Weeks after planting. NS = Not significant. * Treatments had not been applied at the time of the observation.

[3]Means followed by the same letter(s) within a column are not significantly different using Duncan's multiple Range Test (DMRT).

Weed-infestation until 6 weeks after planting resulted in significantly lower vigour score compared with that infested for 3 weeks after planting only. The two treatments were however comparable in vigour score to those of the crops kept weed-free until 3 and 6 weeks after planting. The crop kept weed-free until 9 weeks after planting had significantly higher vigour score than that kept weed-free for 3 weeks after planting only and those infested until 6 and 9 weeks after planting. In addition, crop weed-infested until 9 weeks after planting resulted in significantly lower crop vigour score than that infested until 3 weeks after planting and that kept weed-free initially for 6 weeks after planting only.

The crop kept weed-free until harvest had comparable vigour score to the maximum obtained with crop kept weed-free initially until 9 weeks after planting. Both the crop kept weed-free until 6 weeks after planting and that weed-infested until 3 weeks after planting only had comparable crop vigour scores to that kept weed-free throughout the crop life cycle. Similarly, crop kept weed-free for 3 weeks after planting only had significantly higher crop vigour score than that weed-infested till harvest.

The interaction between varieties and period of weed interference on crop vigour score was not significant (Table 6).

4.1.3 Plant height

Variety Greta had taller plants than variety B7906-1 at 9 weeks after planting (Table 6). The plants kept weed-free for 3 weeks after planting were taller than those weed-infested until 6 weeks after planting (Table 6). Although not significant, plots kept weed-free until 3 and 6 weeks after planting and those infested for 6 and 9 weeks after planting resulted in shorter plants than those kept weed-free until 9 weeks after planting and those weed-infested for 3 weeks after planting only. The interaction between variety and period of weed infestation was however not significant.

4.1.4 Leaf production

The two varieties differed significantly in both leaf number at 9 weeks after planting and dry matter production per plant at 6 and 9 weeks after planting. The period of weed interference also had significant effect on leaf production (Table 6). At 6 weeks after planting, only leaf dry matter was obtained with variety B7906-I excelling variety Greta. However, at 9 weeks after planting, variety Greta had higher leaf count and dry matter production than B7906-I.

At 6 weeks after planting, the crop kept weed-free initially for 6 weeks after planting had higher leaf dry matter production than that weed-infested until 6 weeks after planting. Crop kept weed-free until 9 weeks after

planting resulted in significantly higher leaf dry matter production than those kept weed-free for 3 and 6 weeks after planting and those weed-infested for 6 and 9 weeks after planting. Crop kept weed-free for various periods had significantly higher leaf dry matter production per plant than those weed-infested for 6 and 9 weeks after planting. In addition, crop weed-infested for 6 and 9 weeks after planting resulted in significantly lower leaf dry matter production than that infested for 3 weeks after planting only.

The crop weed-infested until 9 weeks after planting had significantly lower number of leaves per plant compared with that kept weed-free until 9 weeks after planting, while crop weed-infested initially for 3 weeks after planting and those kept weed-free for various periods did not differ significantly in number of leaves per plant.

4.1.5 Leaf area and leaf area index

The leaf area (LA) and leaf area index (LAI) were significantly affected by both varieties of potato and periods of weed interference at 6 and 9 weeks after planting. Variety B7906-I had larger LA and LAI at 6 WAP, but was excelled by plants of Greta variety at 9 weeks after planting (Table 7).

LA and LAI per plant were similarly affected by period of weed interference at 6 weeks after planting.

Table 7: Effect of period of weed interference on Leaf area, Leaf area index, haulm dry weight, relative growth rate and Crop growth rate of two potato varieties in 1985 wet season, at Samaru.

Treatments	Leaf area[1] (cm^2)		Leaf area index		Haulm dry matter per plant (g)		Relative growth rate g/g/wk		Crop growth rate (g)/wk	
	6 WAP[1]	9 WAP	6 WAP	9 WAP	6 WAP	9 WAP	6 WAP	9 WAP	6 WAP	9 WAP
Potato varieties										
B7906-I	1751[a2]	1928[b]	0.804[a]	0.888[b]	10.35[a]	13.94[b]	0.427[b]	0.136[b]	2.432	1.68[b]
Greta	1426[b]	3390[a]	0.547[b]	1.507[a]	8.12[b]	21.30[a]	0.542[a]	0.296[a]	2.245	3.95a
$SE_{\pm}$	94.9	208.4	0.04	0.11	0.52	1.21	0.03	0.02	0.18	0.34
									NS	
Period of weed interference										
Weed-free for 3 WAP[1]	1689[a]	2343[b]	0.818[a]	1.091[b]	10.17[a]	17.41[b]	0.582[a]	0.219[ab]	2.443[a]	3.02[b]
Weed-free for 6 WAP	1638[a]	2322[bc]	0.754[a]	1.083[b]	11.65[a]	17.21[b]	0.580[a]	0.221[ab]	2.545[a]	3.61[b]
Weed-free for 9 WAP	*	3929[a]	*	1.746[a]	*	23.46[a]	*	0.259[a]	*	3.84[a]
Weed-free till harvest	*	*	*	*	*	*	*	*	*	*
Weed-infested for 3 WAP	1662[a]	3678[a]	0.785[a]	1.634[a]	10.03[a]	21.42[a]	0.536[a]	0.254[a]	2.617[a]	4.77[a]
Weed-infested for 6 WAP	1248[b]	1933[bc]	0.554[b]	0.992[b]	7.10[b]	13.73[c]	0.327[b]	0.150[b]	1.583[b]	1.49[c]
Weed-infested for 9 WAP	*	1464[c]	*	0.652[b]	*	11.87[c]	*	0.154[b]	*	1.56[c]
Weed-infested untill harvest	*	*	*	*	*	*	*	*	*	*
$SE_{\pm}$	189.74	416.80	0.089	0.21	1.04	2.42	0.06	0.03	0.37	0.67
Interaction of varieties and period of weed interference										
$SE_{\pm}$	268.3	589.8	0.125	0.298	1.48	3.42	0.08	0.05	0.97	1.48
	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[1]Weeks after planting.
NS = Not significant.
* Treatments had not been applied at the time of observation.

[2]Means followed by the same letter(s) within a column are not significantly different using Duncan Multiple Range Test (DMRT).

Plants kept weed-free initially for 3 and 6 weeks after planting and those weed-infested for 3 weeks after planting resulted in significantly higher LA per plant and LAI than those of plants weed-infested until 6 weeks after planting.

Plants kept weed-free until 9 weeks after planting and those weed-infested for 3 weeks after planting only had similar leaf area and were significantly higher than those of all the other treatments. Plants of plots kept weed-free for 3 weeks after planting only resulted in higher leaf area than that infested for 9 weeks after planting. Although weed infestation until 9 weeks after planting resulted in leaf area comparable with that of the plant infested for 6 weeks after planting, it resulted in significantly lower leaf area than infestation for 3 weeks after planting only. Similarly, leaf area and leaf area index of plants kept weed-free until 9 weeks after planting and that weed-infested for 3 weeks after planting only were significantly higher than those, of plants kept under various periods of weed interference.

4.1.6 Haulm dry matter production

The effect of varieties and periods of weed interference on haulm dry matter production was significant at 6 and 9 weeks after planting. Variety B7906-I resulted in higher haulm dry matter production than Greta at 6 weeks after planting, while Greta

variety excelled B7906-I in haulm dry matter production at 9 weeks after planting. Interaction of variety and period of weed interference on haulm dry matter production was however not significant (Table 7).

Haulm dry matter obtained on the plots kept weed-free for various periods and those infested for 3 weeks after planting were significantly higher than those weed-infested until 6 weeks after planting. Crop kept weed-free until 9 weeks after planting and that infested for 3 weeks after planting resulted in significantly higher haulm dry matter production than those exposed to various periods of weed interference. In addition, crops kept weed-free until 6 weeks after planting and earlier had higher haulm dry matter production than those weed-infested for 6 weeks after planting and more (Table 7).

4.1.7 Crop growth rate and relative growth rate

Table 7 shows that both the crop growth rate (CGR) and relative growth rate (RGR) were affected by potato varieties and period of weed interference at 6 and 9 weeks after planting. At 6 WAP, although varietal effects on CGR was not significant, variety Greta had higher RGR rate than variety B7906-I. At 9 WAP, Greta had higher CGR and RGR compared with variety B7906-I.

Crop kept weed-free initially for 3 and 6 weeks after planting gave significantly higher CGR and

RGR than those weed-infested for 6 weeks after planting.

Crop kept weed-free until 9 weeks after planting and that weed-infested initially for 3 weeks after planting only resulted in higher CGR than those kept weed-free for 3 and 6 weeks after planting only. RGR for these treatments however did not differ significantly. Crop weed-infested initially for 3 weeks after planting and those kept weed-free for various periods also had higher CGR and RGR than those infested with weeds for 6 and 9 weeks after planting (Table 7). Interaction of variety and period of weed interference at both 6 and 9 weeks after planting was not significant.

4.1.8 Pre-harvest tuber production

The two potato varieties differed significantly in both tuber dry weight per plant at 6 and 9 weeks after planting and tuber number per plant at 9 weeks after planting (Table 8). At 6 weeks after planting, variety L7906-1 had higher tuber dry weight than variety Greta while at 9 weeks after planting, Greta had higher tuber number and dry weight per plant than variety L7906-1.

The crop weed-infested until 6 weeks after planting produced lower tuber dry weight per plant than that kept weed-free until 6 weeks after planting. In addition, the tuber weight of crop kept weed-free for 3 weeks after planting did not differ significantly from that infested

Table 8: Effect of period of weed interference on pre-harvest number and dry weight of potato tubers in 1985 wet season at Samaru.

Treatments	Tuber dry weight g/plant 6 WAP[1]	Tuber dry weight g/plant 9 WAP	Number of tubers per plant 9 WAP
Potato varieties			
B7906-I	27.14[a*]	33.5[b]	7.8[b]
Greta	20.12[b]	40.2[a]	10.8[a]
SE±	2.44	2.30	0.22
Period of weed interference			
Weed-free for 3 WAP[1]	32.79[a]	34.8[c]	10.5[a]
Weed-free for 6 WAP	37.72[a]	54.1[a]	12.7[a]
Weed-free for 9 WAP	**	45.5[ab]	10.2[a]
Weed-free until harvest	**	**	**
Weed-infested for 3 WAP	25.28[bc]	37.4[bc]	12.2[a]
Weed-infested for 6 WAP	17.85[c]	30.3[c]	6.7[b]
Weed-infested for 9 WAP	**	30.2[c]	6.0[b]
Weed-infested until harvest	**	**	**
SE±	4.88	4.54	1.64
Interaction of varieties and weed interference			
SE±	6.90 NS	6.49 NS	2.32 NS

[1]Weeks after planting

*Means followed by the same letter(s) within a column are not significantly different using Duncan's Multiple Range Test (DMRT). NS = Not significant.

** Treatments had not been applied at the time of observation.

until 3 weeks after planting.

At 9 weeks after planting, crops weed-infested for 6 and 9 weeks after planting and that kept weed-free until 3 weeks after planting had significantly lower tuber dry weight compared with that kept weed-free until 9 weeks after planting. Tuber dry weight of the crops kept weed-free until 6 and 9 weeks after planting were similar and significantly higher than that of the crop kept weed-free until 3 weeks after planting. Similarly, keeping crop weed-free until 9 weeks after planting resulted in tuber dry weight that was comparable with that weed-infested for 3 weeks after planting only.

Plots kept weed-free for various periods and those weed-infested until 3 weeks after planting had significantly higher number of tubers per plant than those weed-infested until 6 and 9 weeks after planting.

4.1.9 The effect of period of weed interference on yield of potato at harvest

At harvest, the two potato varieties were graded into small-sized tubers (less than 3.5 cm diameter, 7.4-47.g. weight) medium-sized tubers (with diameter of 3.5-4.5 cm, 48.0-96.0g weight) and large-sized tubers (diameter > 4.5 cm, 96.0g weight). The effect of period of weed interference on number and yield of various grades and total tuber yield and number at harvest are

Table 9: Effect of period of weed interference on number and yields of various sizes of potato tuber, in 1985 wet season, at harvest at Samaru.

Treatments	Potato tuber yield (t/ha)				Potato tuber number (x 1000/ha)			
	Total	Large-sized	Medium-sized	Small-sized	Total	Large sized	Medium-sized	Small-sized
Potato varieties								
P7906-I	9.31^{b}	1.33^{b}	5.97^{b}	1.58	433.02^{b}	14.9^{b}	177.7^{b}	242^{b}
Greta	11.94^{a}	2.06^{a}	7.84^{a}	1.95	474.35^{a}	18.6^{a}	230.9^{a}	313^{a}
SE±	0.47	0.26	0.55	0.19	35.21	2.88	12.78	26.0
				NS				
Period of weed interference								
Weed-free for 3 WAP[1]	10.75^{de*}	1.41^{cd}	7.67^{ab}	1.67^{cd}	506.06^{ab}	14.4^{d}	225.5^{a}	272^{a}
Weed-free for 6 WAP	12.41^{bc}	2.18^{bc}	6.98^{b}	3.26^{a}	577.36^{a}	22.2^{c}	227.3^{a}	328^{a}
Weed-free for 9 WAP	14.26^{ab}	3.54^{a}	9.13^{a}	1.58^{cde}	661.24^{a}	31.9^{a}	249.6^{a}	301^{a}
Weed-free until harvest	14.57^{a}	2.74^{ab}	9.86^{a}	1.97^{bc}	581.15^{ab}	23.2^{bc}	264.8^{a}	331^{a}
Weed-infested for 3 WAP	13.65^{ab}	2.70^{ab}	9.02^{a}	1.92^{bcd}	528.28^{ab}	24.1^{b}	224.1^{a}	284^{a}
Weed-infested for 6 WAP	10.51^{de}	1.56^{de}	7.32^{b}	2.63^{ab}	492.26^{bc}	7.7^{d}	219.5^{a}	27^{a}
Weed-infested for 9 WAP	4.85^{e}	0.29^{de}	3.59^{c}	1.08^{d}	422.72^{cd}	5.6^{d}	139.6^{b}	280^{a}
Weed-infested until harvest	4.15^{e}	0.15^{e}	3.00^{c}	1.00^{e}	256.04^{e}	6.0^{d}	93.1^{b}	156^{b}
SE±	0.94	0.53	1.10	0.38	70.42	5.75	25.55	52.2^{1}
Interaction of varieties and period of weed interference								
SE±	1.32	NS NS	NS NS	NS NS	99.30 NS	8.14 NS	36.13 NS	73.60 NS

[1]WAP = Weeks after planting. NS = Not significant.

*Means followed by the same letter(s) within a column are not significantly different using Duncan's Multiple Range Test (DMRT).

Number and yield of small-sized tubers: The effects of potato varieties and period of weed interference on number of small-sized tubers at harvest was significant. Variety Greta had higher number of tubers than B7906-I (Table 9). Although the yield of small-sized potato did not follow any definite trend, the crops kept weed-free for various periods and those weed-infested initially for 3 and 6 weeks after planting had significantly higher yields than that of crop infested for 9 WAP and throughout. Crop kept weed-free until 6 weeks after planting had the highest tuber yield which was only comparable to that of the crop weed-infested for 6 WAS only.

The highest yield reduction, 0.52 t/ha per week of small-sized tubers, occurred when plots were initially weed-infested for a further 3 weeks beyond the initial 6 weeks after planting. The highest increase in yield of 0.56 t/ha weekly resulted from keeping the crop weed-free for further 3 weeks beyond the initial 6 weeks after planting. Small sized yield increase of 0.53 and 0.13 t/ha per week occurred by keeping the crops weed-free for further 3 weeks beyond the initial 3 and 6 weeks after planting respectively.

Number and yield of medium-sized tubers: The two potato varieties differed significantly in number and yield of medium-sized tubers. Variety Greta had significantly higher number and yield of medium-sized tuber than variety B7906-I, while the interaction of variety and period of

weed interference was not significant (Table 9).

Crop kept weed-free for various periods and those weed-infested until 3 and 6 weeks after planting had significantly higher number of medium-sized tubers than those infested until 9 weeks after planting and harvest. In addition, crops kept weed-free until 9 weeks after planting and throughout the crop life cycle, and that weed-infested initially for 3 weeks after planting had higher medium-sized tuber yield than that kept weed-free or weed-infested until 6 weeks after planting. Similarly, weed-infestation until 9 weeks after planting and harvest resulted in significantly lower yield of medium-sized tubers compared with infestation for 6 weeks after planting.

Number and yield of large-sized tubers: The two potato varieties differed significantly in the yield of large-sized tubers with variety Greta having higher yield than variety B7906-I. Similarly, the period of weed interference also had significant effect on the yield of large-sized tubers.

The highest number of large-sized tubers obtained when the crop was kept weed-free until 9 WAP, was significantly higher than those obtained with the other crops exposed to various periods of weed interference. Crop kept weed-free for 6 weeks after planting and until harvest and that weed-infested initially for 3 weeks after

those weed-infested until 6 weeks after planting and more and that kept weed-free until 3 WAP. In addition, crop weed-infested for 3 weeks after planting also had higher number of large-sized tubers than those crops kept weed-free until 6 weeks after planting although they were both comparable to that obtained with the crop kept weed-free throughout.

Crop weed-infested until 6 weeks after planting and more and that kept weed-free initially for 3 weeks after planting resulted in significantly lower yield of large-sized tuber at harvest than those kept weed-free until 9 weeks after planting and that weed-infested for 3 weeks after planting only. Crop kept weed-free until 6 weeks after planting also had lower yield of large-sized tuber compared with the highest obtained with the crop kept weed-free until 9 weeks after planting. Similarly, crop kept weed-free until 6 weeks after planting had significantly higher large-sized tuber yield than those weed-infested until 6 weeks after planting and more. The highest increase in yield of large-sized tubers, 0.45 t/ha per week occurred when the crop was kept weed-free for a further 3 weeks beyond the first 6 weeks after planting, while the largest reduction of 0.71 t/ha weekly occurred with the crop infestation / for a further 3 weeks beyond the first 3 weeks after planting. Weed infestation for a further 3 weeks beyond 6 and 9 weeks after planting respectively resulted in large-sized tuber losses of

0.09 and 0.05 t/ha weekly. Unchecked weed growth until 9 weeks after planting and harvest resulted in large-sized tuber yield losses of 91.8% and 95.8% respectively compared with the best obtained by keeping the crop weed-free until 9 weeks after planting. Crops kept weed-free initially until 3 and 6 weeks after planting had yield losses of about 60.2% and 38.4% respectively compared with the highest yield obtained on plots kept weed-free until 9 weeks after planting (Table 9).

Total number and yield of potato: The effects of variety and period of weed interference and their interactions on total number and yield of tubers were significant (Table 9). Variety Greta had higher number and yielded more tubers than B7906-I at harvest.

Crop kept weed-free until 9 weeks after planting had significantly higher tuber number than those weed-infested for 6 weeks after planting and more. In addition weed-infestation throughout the crop life cycle resulted in lower potato number compared with those exposed to various periods of weed interference. Tuber yields of crops kept weed-free for 3 and 6 weeks after planting and those weed-infested for 6 weeks after planting and more were lower than those of the crop kept weed-free throughout. Tuber yield of the plot weed-infested for 6 weeks after planting was also lower than those of the plots infested for 3 weeks

until 6 weeks after planting had higher tuber yield than those infested for a longer period.

In this experiment, the highest gain in yield of 0.62 t/ha per week was obtained when the crop was kept weed-free for a further 3 weeks beyond the first 6 weeks after planting. Similarly, the highest reduction in potato tuber yield of 1.09 t/ha per week occurred when the crop was infested for a further 3 weeks beyond the first 6 weeks after planting (Table 9). Weed infestation until 6 and 9 weeks after planting resulted in about 27.8% and 66.6% reduction in total tuber yield respectively, while keeping the crop weed-free for 3 and 6 weeks after planting resulted in 73.8 and 86% of the maximum tuber yield obtained with the crop kept weed-free throughout its life cycle. Unchecked weed growth throughout the crop life cycle caused about 71.5% reduction in total tuber yield at harvest compared with the crop kept weed-free throughout (Table 9).

The interaction of varieties and period of weed inter-ference on potato tuber yields is significant, as shown in Table 10. The crops of B7906-I , kept weed-free for 6 weeks after planting and more and that weed-infested unitially for 3 weeks after planting only had comparable yields to that kept weed-free until harvest. In contrast, Greta crop kept weed-free until 6 weeks after planting produced lower tuber yield than those kept weed-free until 9 weeks after planting and

Table 10: Interaction of varieties and period of weed interference on tuber yield of potato in 1985 wet season at Samaru.

Treatments	Total yield (t/ha)	
Varieties	B7906-I	Greta
	9.31	11.94
SE±	0.468	
Period of weed interference		
Weed-free for 3 WAP[1]	9.10^{c+}	12.40^{b}
Weed-free for 6 WAP	11.10^{ab}	13.70^{b}
Weed-free for 9 WAP	11.83^{a}	16.70^{a}
Weed-free until harvest	11.98^{a}	17.20^{a}
Weed-infested for 3 WAP	11.40^{ab}	15.80^{a}
Weed-infested for 6 WAP	10.10^{bc}	10.90^{c}
Weed-infested for 9 WAP	5.30^{d}	4.40^{d}
Weed-infested until harvest	3.60^{e}	4.70^{d}
Interaction of varieties and period of weed interference		
SE±	1.324	

[1]Weeks after planting

[+]Means followed by the same letter(s) within a column are not significantly different using Duncan Multiple Range Test (DMRT).

more and that weed-infested for the first 3 weeks after planting (Table 10). In addition, B7906-I crop kept weed-free until 3 weeks after planting had comparable yield to that kept weed-free until 6 weeks after planting, the yield of Greta crop kept weed-free until 3 weeks after planting was lower than that of the corres pending latter treatment. In the trial, weed removal after the initial infestation for 9 weeks after planting only resulted in significant tuber yield increase compared with infestation until harvest in B7906-I (Table 10).

The highest yield gains of 0.67 and 1.00 t/ha per week each for B7906-I and Greta occurred when the crops were kept weed-free for a further 3 weeks beyond the first 3 and 6 weeks after planting, respectively. However, highest yield losses of 1.6 and 1.83 t/ha per week for B7906-I and Greta respectively were obtained with the response of the crops to weeds for a further 3 weeks beyond the initial infestation 6 weeks after planting. Unchecked weed growth until harvest resulted in tuber yield losses of 69.1% and 72.7% respectively for B7906-I and Greta compared with those obtained with the coresponding crops kept weed-free until harvest. (Table 10).

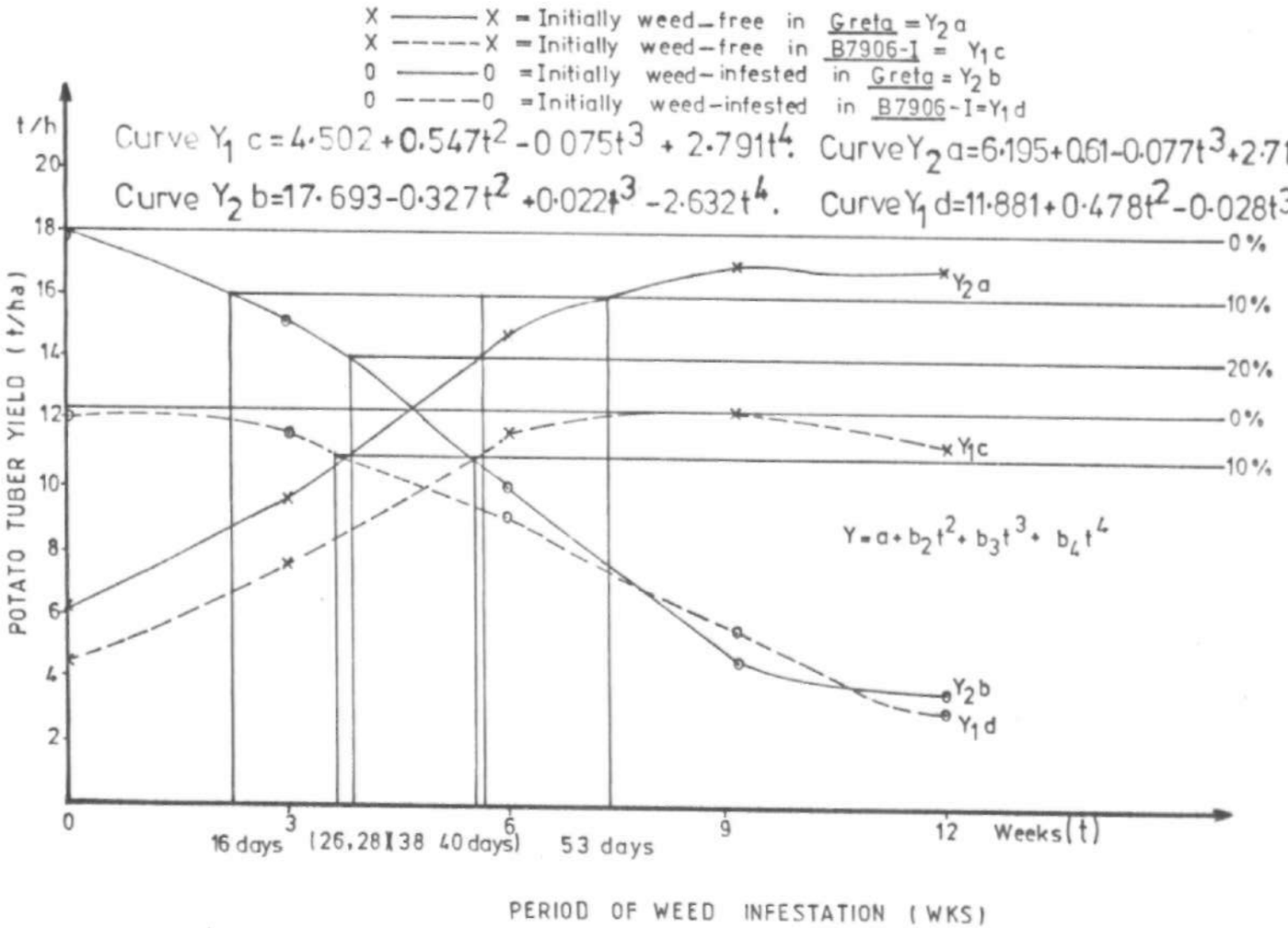


Fig. 1. Fitted values of total tuber yields for Greta and B 7906-1 varieties as affected by period of weed interference at Samaru, 1985.

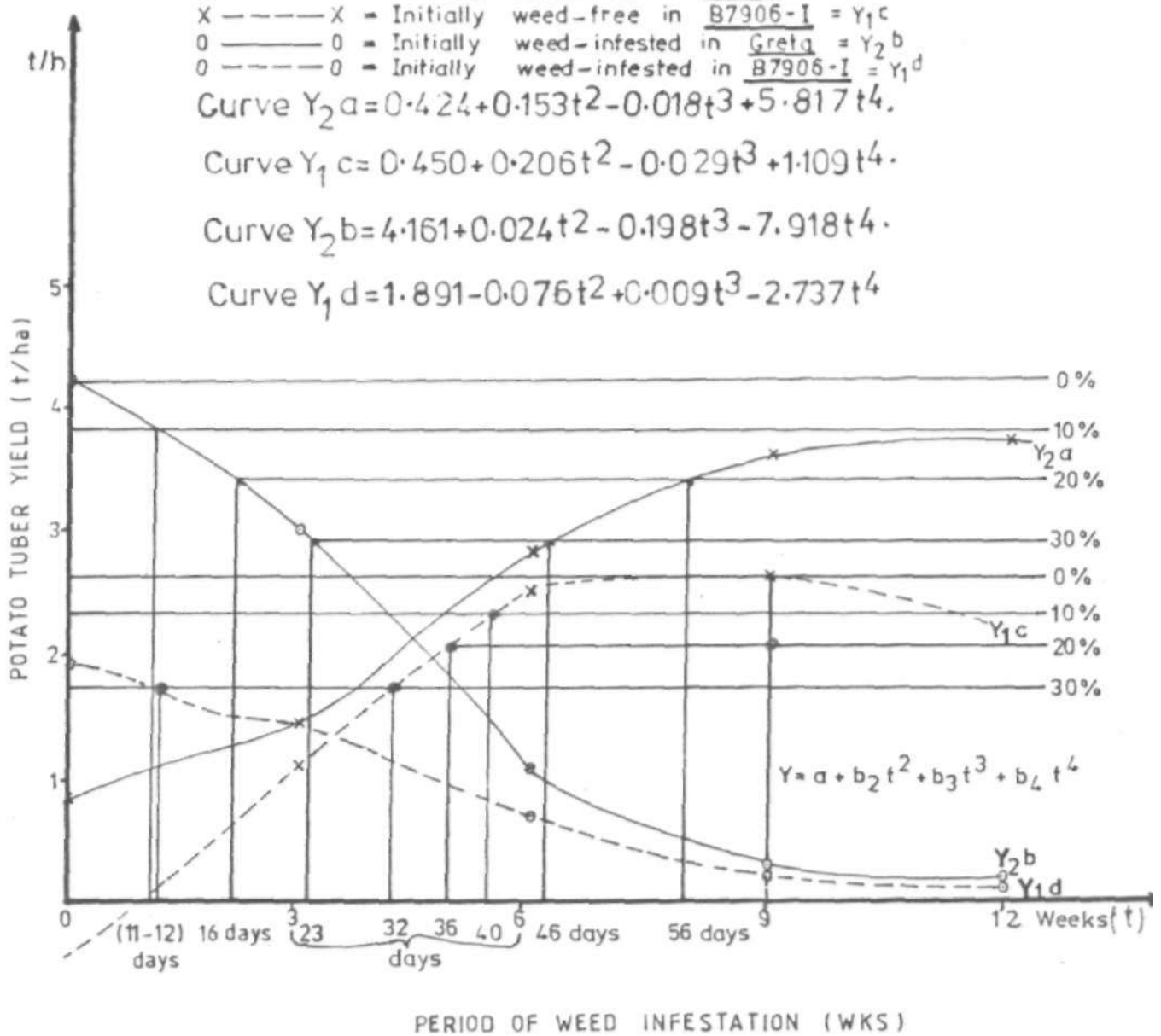


Fig. 2. Fitted values of large-sized tuber yields for Greta and B 7906-1 varieties as affected by period of weed interference at Samaru, 1985.

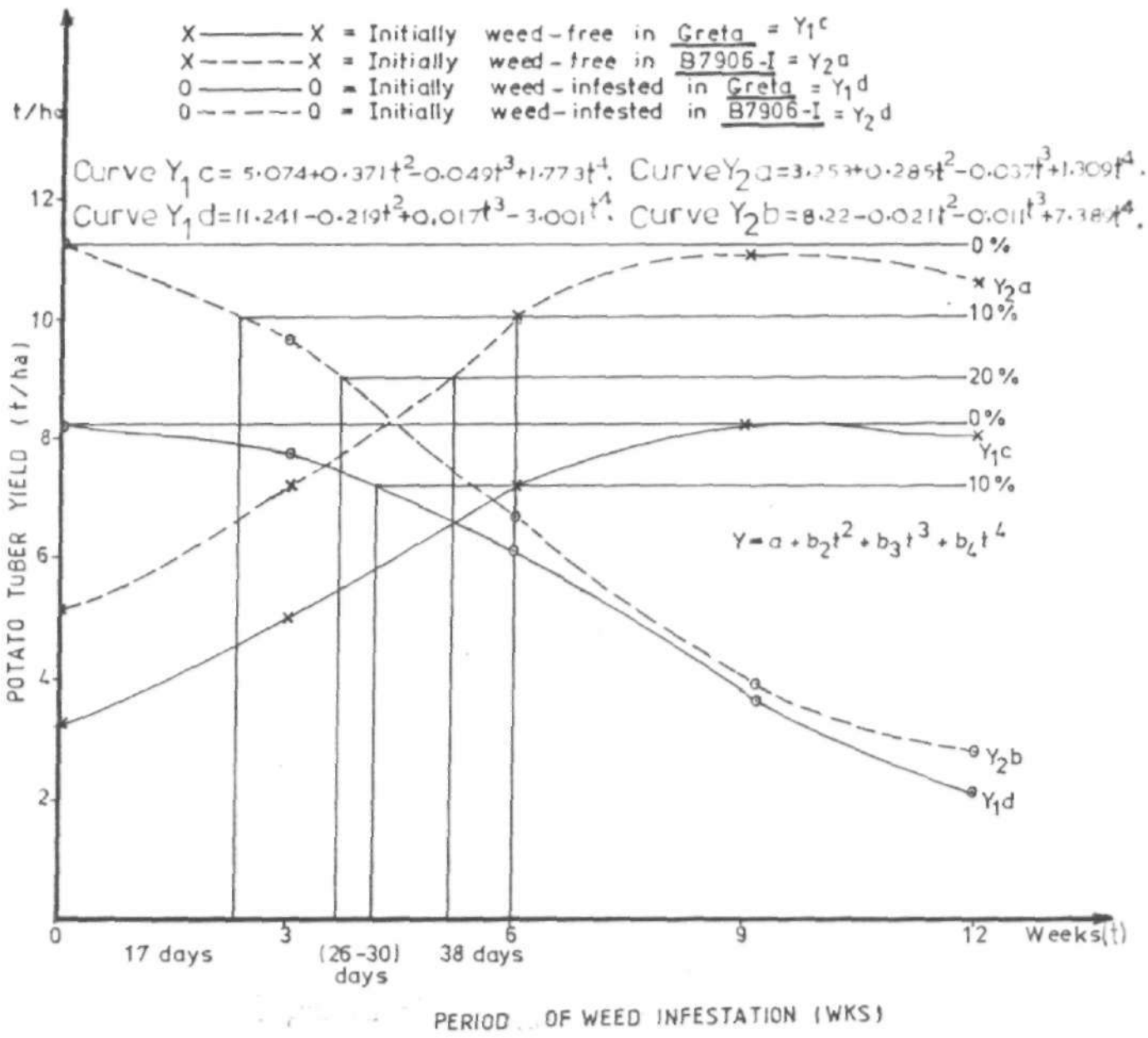


Fig. 3. Fitted values of medium sized tuber yields for Greta and B 7906-1 varieties as affected by period of weed interference at Samaru, 1985.

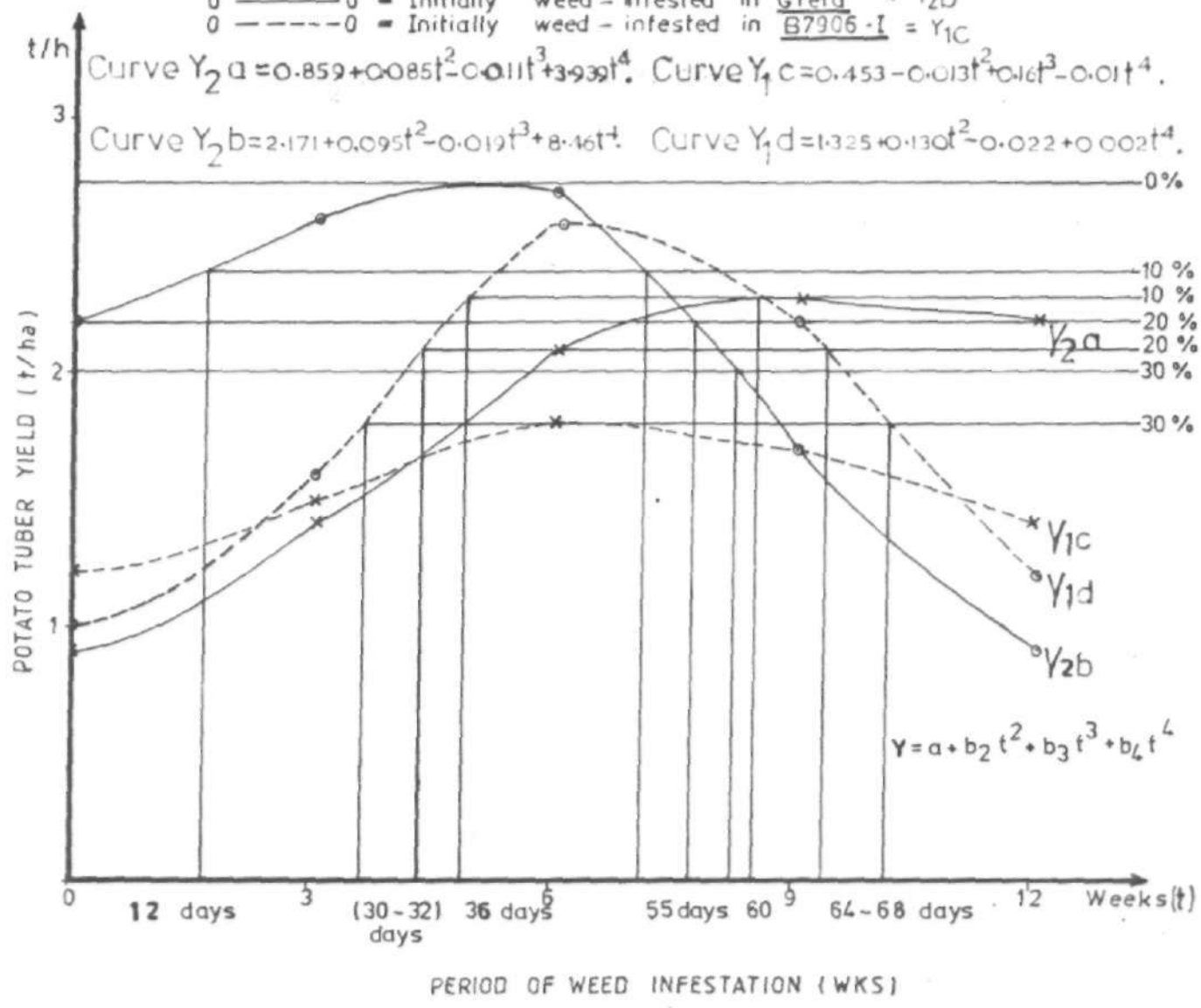


Fig. 4. Fitted values of small-size tuber yields for Greta and B 7906-1 varieties as affected by period of weed interference at Samaru, 1985.

4.1.10 Predicted total and graded yields of Greta and B7906-I varieties as affected by period of weed interference

Figures 1-4 contain curves on predicted values of both total and graded yields of potato tuber for varieties Greta and B7906-I using the equation below:

$$Y = ab_2Z_2 + b_3Z_3$$

where Z_2, Z_3 are functions of time of weeding chosen such that the slope is zero at t = 0 (time of planting) and at t = 12 weeks (time of harvest) using the quartic equation

$$Y = a + b_2t^2 + b_3t^3 + b_4t^4$$

This equation gives a sigmoid relationship of yield and weeding time which is asymptotic both at t = 0 and t = weeks. In this study the estimated values of coefficient of determination for linear, quadratic, cubic and quartic equations were 85.37, 86.64, 87.84 and 96.35% respectively. As indicated in these values, the quartic equation is the best fitted curve for this number of points.

In figure 1, it was estimated that about 10% losses in total yield would occur in variety Greta if the crop should be kept weed-free from 16 to 53 days after planting. With this variety, it was required to keep the crop weed-free throughout the life cycle in order to obtain maximum potato tuber

yield. However, with variety B7906-I, in order to obtain maximum yield and 10% yield reduction, the crop should be kept weed-free until 50 days after planting and from 26 to 39 days after planting respectively (Figure 1). Similarly as indicated on Figure 2, about 10% yield losses in large-sized tubers of Greta and B7906-I would occur if both varieties were kept weed-free from 11 days after planting to harvest and from the time of planting to 40 days after planting respectively. Keeping varieties Greta and B7906-I weed-free respectively from 17 to 42 days after planting and 30 to 42 days after planting would cause about 10% reduction in medium-sized tuber production (Fig. 3).

Figure 4 has shown that about 10% reduction in small-sized potato tuber yields for Greta and B7906-I occurred when the crops were infested from 12 to 55 days after planting and from 36 to 60 days after planting respectively.

4.1.11 Effect of variety and period of weed interference on weed cover score and weed dry matter production

Weed infestation throughout the crop growth period as reflected in the weed scores at 6 and 9 weeks after planting and at harvest, and weed dry matter production were neither affected by varieties nor their interaction with the period of weed interference. The effect of period of weed interference was however significant on weed cover scores and weed dry matter production

Table 11: Effect of period of weed interference on weed cover score and cumulative weed dry matter production in 1985 wet season at Samaru.

Treatments	Weed cover score[1]			Cumulative weed dry matter at harvest (t/ha)
	6 WAP[2]	9 WAP	Harvest	
Potato varieties				
B7906-I	3.58	3.96	2.40	6.26
Greta	4.03	4.26	2.74	6.42
SE±	0.22	0.16	0.2	0.77
Period of weed interference				
Weed-free for 3 WAP	2.50[b+]	5.12[b]	5.27[b]	10.68[b]
Weed-free for 6 WAP	0.77[c]	3.50[c]	3.70[c]	6.82[c]
Weed-free for 9 WAP	*	1.08[d]	1.00[d]	2.71[d]
Weed-free until harvest	*	*	0.00[e]	0.30[d]
Weed-infested for 3 WAP	1.42[b]	1.03[d]	0.00[e]	0.49[d]
Weed-infested for 6 WAP	6.83[a]	0.77[d]	0.00[e]	10.92[b]
Weed-infested for 9 WAP	*	9.17[a]	0.00[e]	14.16[a]
Weed-infested until harvest*		*	8.58[a]	16.59[a]
SE±	0.44	0.31	0.41	1.54
Interaction of varieties with period of weed interference				
SE±	0.68 NS	0.44 NS	0.57 NS	2.15 NS

[1]Weed cover score using (0-10) scale, where 0 - no weeds and 10 = complete weed infestation.

[2]Weeks after planting.

[+]Means followed by the same letter(s) within a column are not significantly different using Duncan's Multiple Range Test (DMRT).

NS = Not significant.

*Treatments had not been applied at the time of observation.

At 6 and 9 weeks after planting and at harvest, plots kept weed-free for 3 weeks after planting had higher weed scores and dry matter production than those kept weed-free until 6 weeks after planting. Plots weed-infested until 6 weeks after planting had higher weed score than other plots exposed to shorter periods of weed interference. Similarly, plots weed-infested until 9 weeks after planting had higher weed score than those infested for shorter periods. Weed scores of plots kept weed-free until 6 weeks after planting and earlier were however higher than those of the plots infested for 3 and 6 weeks after planting. At harvest, crop weed-infested until harvest had higher weed score than those kept weed-free initially for 9 weeks after planting and earlier, while no weed growth was recorded on plots weed-infested initially until 9 weeks after planting and less.

Table 11 also shows cumulative weed dry weight during weeding operations and at final crop harvest. This is an indication of total weed dry matter accumulation as affected by each treatment throughout the crop life cycle. Weed dry matter production on plots weed-infested until 9 weeks after planting was comparable to those of plots infested until harvest, and were significantly higher than those of all the other treatments. In addition, plots kept weed-free for 3 weeks after planting and those weed-infested for

Table 12: Correlation between yield, weed cover score, weed dry matter, and crop growth parameters as affected by period of weed interference on two potato varieties,

	Yield		Crop growth parameter									
	Total tuber yield at harvest	Total number of tubers at harvest	Crop Vigour score at 9 WAP	Plant height at 9 WAP	Leaf number per plant at 9 WAP	Leaf dry weight per plant at 9 WAP	Leaf Area at 9 WAP	Haulm dry matter per plant at 9 WAP	Relative growth rate at 6 WAP	Crop growth rate at 6 WAP	Dry tuber weight at 6 WAP	Crop stand count at harvest
Total tuber yield at harvest	1.00*											
Total number of tubers at harvest	0.805	1.000										
Crop Vigour score at 9 WAP[1]	0.832	0.700	1.000									
Plant height at 9 WAP	0.439	0.344	0.394	1.000								
Leaf number per plant 9 WAP	0.630	0.651	0.642	0.322	1.000							
Leaf dry weight per 9 WAP	0.734	0.611	0.669	0.663	0.540	1.000						
Leaf area at 9 WAP	0.596	0.477	0.711	0.291	0.323	0.622	1.000					
Haulm dry matter at 9 WAP	0.642	0.319	0.816	0.316	0.212	0.671	0.314	1.000				
Relative growth rate 6 WAP	0.342	0.544	0.579	0.371	0.376	0.744	0.299	0.791	1.000			
Crop growth rate at 6 WAP	0.477	0.414	0.466	0.648	0.268	0.568	0.766	0.689	0.817	1.000		
Dry tuber weight at 6 WAP	0.293	0.184	0.231	0.085	0.086	-0.042	0.297	0.106	0.229	0.322	1.000	
Crop stand count	0.316	0.367	0.444	-0.001	0.138	-0.146	0.177	0.264	0.197	0.213	0.164	1.000
Weed cover score at 9 WAP[1]	-0.695	-0.438	-0.405	-0.175	-0.303	-0.365	-0.418	-0.111	-0.331	-0.486	-0.305	-0.288
Cumulative weed dry matter production at harvest	-0.637	-0.395	-0.390	-0.212	-0.252	-0.443	-0.538	-0.344	-0.467	-0.611	-0.260	-0.288

[1]Weeks after planting.

*All values above 0.288 are significant at 5% level of probability

6 weeks after planting had higher weed dry matter production than those that were weed-free until 6 weeks after planting and more..

The highest weekly reduction in weed dry matter production of 1.37 t/ha occurred when the plots were kept weed-free for a further three weeks beyond the first 6 weeks after planting. Similarly, the highest increase in weed dry matter production of 3.34 t/ha per week was obtained on the plots weed-infested for further 3 weeks beyond the first 3 weeks after planting (Table 11).

4.1.12 Relationship between potato yield, growth parameters, weed cover score, and weed dry matter production as affected by period of weed interference

As shown in Table 12, the yield of potato tuber was correlated positively with the number of tubers per hectare at harvest, crop vigour score, plant height, leaf-number per plant, leaf dry weight per plant, leaf area, haulm dry matter, crop growth rate, relative growth rate and stand count, and negatively with weed cover score at 9 weeks after planting and cumulative weed dry matter production at harvest.

Number of tubers per hectare at harvest was also positively correlated with crop vigour, plant height, leaf number per plant, leaf dry weight per plant, leaf area, relative growth rate, crop growth rate at 6 weeks after planting and stand count, and negatively correlated

with weed cover score and cumulative weed dry matter production at harvest.

Crop vigour score at 9 weeks after planting was also correlated positively with leaf number, leaf dry weight and leaf area per plant, plant height, haulm dry matter production, crop growth rate, relative growth rate and crop stand count at harvest and negatively with weed parameters.

Plant height significantly correlated positively with leaf number and dry weight per plant, haulm dry matter production, relative growth rate and crop growth rate, and negatively with weed parameters.

Leaf number per plant correlated positively with leaf dry weight per plant, leaf area and relative growth rate, and negatively with weed cover score at 9 weeks after planting and weed dry matter cumulation at harvest. Leaf dry weight per plant at 9 weeks after planting was also correlated with leaf area, haulm dry matter production, relative growth rate and crop growth rate.

Leaf area per plant at 9 weeks after planting strongly correlated with crop growth rate, haulm dry matter production and dry tuber weight at 6 weeks after planting.

Table 13: Effect of weed control treatments on weed cover score and weed dry matter production in 1985 wet season, at Samaru.

Treatments		Weed cover score[1]				Weed dry matter production at harvest(t/			
Herbicides[2]	Rate kg a.i./ha	3 WAP[3]	6 WAP	9 WAP	Harvest	Grass weeds	Broad-leaved weeds	Sedges	Total
Metolachlor + ametryne	1.00 + 0.75	0.30^{b*}	1.83^{bcd}	2.83^{bc}	3.33^{bc}	0.78^{b}	1.70^{c}	0.01	2.49
Metolachlor + ametryne	1.50 + 1.00	0.20^{b}	0.67^{de}	1.67^{cde}	2.50^{c}	0.33^{b}	1.39^{cde}	0.01	1.73
Metolachlor + atrazine	1.33 + 0.67	0.10^{b}	0.83^{cde}	1.37^{cde}	1.67^{de}	0.32^{b}	0.62^{def}	0.00	0.94
Metolachlor + atrazine	2.00 + 1.00	0.07^{b}	0.13^{e}	0.20^{e}	0.30^{e}	0.14^{b}	0.42^{def}	0.02	0.57
Metolachlor + metobromuron	1.00 + 1.00	0.77^{b}	1.33^{bcde}	1.83^{cd}	2.33^{c}	0.43^{b}	1.22^{cdef}	0.04	1.70
Metolachlor + metobromuron	1.50 + 1.50	0.73^{b}	1.17^{cde}	1.67^{cde}	2.17^{cd}	0.29^{b}	1.17^{cdef}	0.03	1.50
Metolachlor + linuron	1.00 + 0.50	1.50^{b}	2.83^{b}	3.67^{b}	4.50^{b}	0.82^{b}	3.39^{b}	0.03	4.25
Metolachlor + linuron	1.50 + 0.75	0.50^{b}	1.83^{bcd}	2.00^{c}	2.33^{c}	0.50^{b}	1.48^{cd}	0.01	1.9
Metolachlor + prometryne	1.00 + 1.00	0.27^{b}	1.17^{cde}	1.50^{cde}	2.00^{cd}	0.34^{b}	1.11^{f}	0.01	1.4
Metolachlor + prometryne	1.50 + 1.50	0.23^{b}	1.00^{cde}	1.67^{cde}	1.83^{cd}	0.31^{b}	0.83^{cdef}	0.01	1.1
Metolachlor + metribuzin	1.00 + 0.25	0.23^{b}	0.83^{cde}	1.33^{cde}	1.33^{de}	0.25^{b}	0.79^{cdef}	0.02	1.0
Metolachlor + metribuzin	1.50 + 0.50	0.00^{b}	0.23^{de}	0.23^{e}	0.30^{e}	0.07^{b}	0.40^{def}	0.01	0.4
Hoe-weeding at 3, 6 WAP	-	-	1.97^{bc}	0.50^{de}	0.20^{e}	0.10^{b}	0.22^{ef}	0.01	0.
Hoe-weeding at 3, 6 and 9 WAP	-	-	1.83^{bcd}	0.53^{de}	0.00^{e}	0.03^{b}	0.12^{f}	0.01	0.
Untreated check	-	4.83^{a}	8.33^{a}	8.50^{a}	8.67^{a}	4.09^{a}	5.87^{a}	0.07	10.
SE±		1.31	0.61	0.65	0.63	0.93	0.92	0.48	0.

[1]Weed cover score using scale (0 - 10); where 0 = no weeds, 10 = complete weed cover

[2]All herbicide treatments were applied a Pre-emergence day after planting. [3]Weeks after planting.

[1]Means followed by the same letter(s) within a column are not significantly different using Duncan's Multiple Range Test (DMRT).

Haulm dry matter production positively correlated with crop growth rate and relative growth rate. Relative growth rate was correlated positively with crop growth rate and negatively with dry tuber weight at 6 weeks after planting and weed parameters. However, crop growth rate was correlated with dry tuber weight at 6 weeks after planting. In addition, there was no correlation between dry tuber weight at 6 weeks after planting and crop stand count at harvest.

At 9 weeks after planting, weed cover score had significant positive correlation with weed dry matter production at harvest and negatively with all crop growth parameters (Table 12).

4.2 Evaluation of Herbicides for Weed Control in Potato

The effect of weed control treatments on weed cover score, weed dry matter production, crop growth parameters and yield are shown in Table 13 to 18.

4.2.1 Weed cover score

All the weed control treatments resulted in significantly lower weed cover scores at 3, 6 and 9 weeks after planting and at harvest compared with the untreated check (Table 13).

At 6 weeks after planting, plots treated with metolachlor plus atrazine at 2.00 + 1.00 kg a.i./ha had significantly lower weed score than those hoe-weeded at

3 weeks after planting, while all the other herbicide treatments had comparable scores to the hoe-weeding treatment. Metolachlor plus linuron at 1.00 + 0.50 kg a.i./ha however resulted in higher weed score than mixtures of metolachlor with ametryne at 1.50 + 1.00 kg a.i./ha, atrazine at 1.33 + 0.67 and 2.00 + 1.00 kg a.i./ha, metobromuron and prometryne each at 1.00 + 1.00 and 1.50 + 1.50 kg a.i./ha respectively. At 9 weeks after planting, all the herbicide treatments except mixtures of metolachlor with ametryne at 1.00 + 0.75 kg a.i./ha and linuron at both rates had comparable weed cover score to the hoe-weeded controls. Mixtures of metolachlor plus metribuzin at 1.50 + 0.50 kg a.i./ha and atrazine at 2.00 + 1.00 kg a.i./ha had lower weed cover scores than those of metolachlor plus ametryne at 1.00 + 0.75 kg a.i./ha and metolachlor plus linuron at both rates. Similarly at harvest, only mixtures of metolachlor with atrazine and metribuzin at both rates, resulted in comparable weed scores to the hoe-weeded controls. The two hoe-weeded controls had similar weed cover scores throughout the growing season.

4.2.2 Weed dry matter production

The weed control treatments only had significant effect on the dry matter production of grass and broadleaved weeds but not on sedges (Table 13). All the weed control treatments resulted in significantly lower dry weights of grasses and broadleaved weeds

Table 14: Effect of weed control treatments on the growth of potato variety Greta in 1985 wet season, at Samaru.

Treatments: Herbicides[1]	Rate (kg a.i./ha)	Crop vigour score		Crop height (cm)		Number of leaves per plant		Leaf dr weight pe plant (g)	
		6 WAP[2]	9 WAP	6 WAP	9 WAP	6 WAP	9 WAP	6 WAP	9 WAP
Metolachlor + ametryne	1.00 + 0.75	6.50^{ab*}	6.50^{ab}	20.23^{ab}	72.9[3]	22.7^{ab}	106.3[3]	4.65^{bcde}	14.95
Metolachlor + ametryne	1.50 + 1.00	5.33^{ab}	6.70^{ab}	16.12^{c}	67.3	14.7^{b}	105.6	3.81^{cde}	14.79
Metolachlor + atrazine	1.33 + 0.67	5.17^{ab}	6.33^{ab}	15.93^{c}	55.2	16.3^{b}	90.0	2.9^{de}	10.46
Metolachlor + atrazine	2.00 + 1.00	5.33^{ab}	6.50^{ab}	16.22^{c}	53.9	26.7^{ab}	98.7	3.7^{bcde}	10.81
Metolachlor + metobromuron	1.00 + 1.00	7.33^{a}	8.00^{a}	21.43^{a}	75.85	32.0^{a}	108.0	16.39^{abc}	17.7
Metolachlor + metobromuron	1.50 + 1.50	7.00^{a}	6.67^{ab}	20.40^{ab}	66.46	17.3^{ab}	98.3	4.04^{bcde}	16.5
Metolachlor + linuron	1.00 + 0.50	5.50^{ab}	5.17^{b}	16.23^{c}	60.10	21.7^{ab}	61.0	4.29^{abcde}	10.1
Metolachlor + linuron	1.50 + 0.75	4.67^{ab}	6.17^{ab}	11.87^{d}	70.90	24.3^{ab}	134.7	4.68^{abcde}	15.6
Metolachlor + prometryne	1.00 + 1.00	5.83^{ab}	6.83^{ab}	17.03^{bc}	65.13	26.7^{ab}	96.0	5.47^{abcde}	10.6
Metolachlor + prometryne	1.50 + 1.50	6.50^{ab}	7.50^{a}	20.57^{ab}	65.00	24.7^{ab}	132.7	6.11^{abcd}	16.
Metolachlor + metribuzin	1.00 + 0.25	7.33^{a}	8.00^{a}	18.33^{abc}	71.22	27.7^{ab}	134.7	7.48^{a}	18.
Metolachlor + metribuzin	1.50 + 0.50	4.33^{b}	6.17^{ab}	16.97^{bc}	55.95	20.0^{ab}	112.3	2.64^{e}	8.
Hoe-weeding at 3 and 6 WAP	-	6.00^{ab}	8.00^{a}	19.83^{ab}	60.00	21.7^{ab}	125.0	6.99^{ab}	14.
Hoe-weeding at 3, 6 and 9 WAP	-	5.17^{ab}	8.00^{a}	19.79^{ab}	61.33	27.7^{ab}	134.0	7.13^{ab}	17.
Untreated check		5.00^{ab}	4.33^{b}	20.13^{ab}	53.70	21.7^{ab}	81.7	3.88^{cde}	7.
SE±		1.16	1.16	6.42	9.53	6.23	34.48	1.34	3

[1]All herbicide treatments were applied Pre-emergence, a day after planting. [2]WAP = Weeks after planting.

[3]Values not Significantly different from each other using Duncan's Multiple Range Test (DMRT).

*Means followed by the same letter(s) within a column are not significantly different using Duncan's Multiple Range Test

compared with the untreated check. Among the herbicide treatments, mixtures of metolachlor with linuron at both rates, ametryne at 1.00 + 0.75 kg a.i./ha produced significantly higher dry weight of broad-leaved weeds than the hoe-weeded controls. However, the herbicide treatments did not differ significantly in the weights of grasses.

The untreated check resulted in significantly higher total weed dry matter production than the other weed control treatments at harvest. In addition, all the herbicide treatments, except mixture of metolachlor with ametryne at 1.00 + 0.75 kg a.i./ha and linuron containing mixtures at 1.00 + 0.50 and 1.50 + 0.75 kg a.i./ha, had comparable total weed dry matter production to the three hoe-weedings treatment.

4.2.3 Crop stand count and vigour score

As shown in Table 16, crop establishment was not significantly affected by the weed control treatments throughout the crop life-cycle. However, the effect of weed control treatments on crop vigour score at 6 and 9 weeks after planting was significant (Table 14).

At 6 weeks after planting, metolachlor plus metribuzin at 1.00 + 0.50 kg a.i./ha had significantly lower crop vigour score than the highest obtained with its lower rate and at both rates of metolachlor plus metobromuron (Table 14). At 9 weeks after planting,

mixtures of metolachlor with either metobromuron; prometryne or metribuzin at 1.00 + 1.00, 1.50 + 1.50 kg a.i./ha or 1.00 + 0.25 a.i./ha, respectively resulted in significantly higher crop vigour scores than metolachlor plus linuron at 1.00 + 0.50 kg a.i./ha, while the other herbicide treatments had comparable scores to the hoe-weeded controls (Table 14).

4.2.4 Plant height

Weed control treatments only had significant effect on crop height at 6 weeks after planting (Table 14). Metolachlor plus metobromuron at 1.00 + 1.00 kg a.i./ha resulted in significantly taller plants than mixtures of metolachlor with ametryne at 1.50 + 1.00 kg a.i./ha, atrazine at both rates, linuron at 1.00 + 0.5 kg a.i./ha, prometryne at 1.00 + 1.00 kg a.i./ha and metribuzin at 1.50 + 0.50 kg a.i./ha. In addition, plots treated with mixtures of metolachlor with prometryne and metribuzin each at both low and high rates, ametryne at 1.00 + 0.75 kg a.i./ha and metrobromuron at 1.5 + 1.5 kg a.i./ha had plants as tall as those of plots that had been weeded once at 3 weeks after planting. These treatments however had taller plants than those of the plots treated with metolachlor plus ametryne at 1.50 + 1.00 kg a.i./ha and metolachlor plus atrazine at both rates.

4.2.5 Leaf production

The number of leaves produced per plant was only significantly affected by weed control treatments at 6 weeks after planting while leaf dry matter production was affected at 6 and 9 weeks after planting (Table 14). The highest number of leaves per plant obtained with metolachlor plus metobromuron at 1.00 + 1.00 kg a.i./ha was significantly higher than those of the plots treated with mixtures of metolachlor with atrazine at 1.33 + 0.67 kg a.i./ha and ametryne at 1.50 + 1.00 kg a.i./ha. These latter herbicide treatments and metolachlor plus metribuzin at 1.50 + 0.50 kg a.i./ha gave lower leaf dry matter production than the hoe-weeded control at 6 weeks after planting. The high rate of metolachlor plus metobromuron also resulted in lower leaf dry matter production than metolachlor plus metribuzin at 1.00 + 0.25 kg a.i./ha.

4.2.6 Leaf area and leaf area index

As shown in Table 15, at 6 weeks after planting, mixtures of metolacnlor, with metobromuron at 1.00 + 1.00 kg a.i./ha, prometryne at 1.50 + 1.50 kg a.i./ha, metribuzin at 1.00 + 0.25 kg a.i./ha had comparable leaf area per plant with the hoe-weeded controls but significantly higher than those of mixtures of metolachlor with ametryne at 1.50 + 1.00 kg a.i./ha, atrazine at both rates, linuron at 1.00 + 0.50 kg

Table 15: Effect of weed control treatments on leaf area, leaf area index, crop growth rate, relative growth rate of potato during the 1985 wet season, at Samaru.

Treatments Herbicides[1]	Rate kg a.i./ha	Leaf area per plant (cm^2) 6 WAP[2]	Leaf area per plant (cm^2) 9 WAP	Leaf area index 6 WAP	Leaf area index 9 WAP	Crop growth rate g/wk 6 WAP	Crop growth rate g/wk 9 WAP	Relative growth rate g/g/wk 6 WAP	Relative growth rate g/g/wk 9 WAP
Metolachlor + ametryne	1.00 + 0.75	1273.6^{ab*}	4091.8^{ab*}	0.59^{abcd}	1.82[3]	1.92^{abc}	5.84[3]	0.46^{ab}	0.41[3]
Metolachlor + ametryne	1.50 + 1.00	1043.7^{b}	4050.8^{ab}	0.46^{cd}	1.80	1.61^{bc}	6.07	0.50^{ab}	0.46
Metolachlor + atrazine	2.00 + 1.00	1085.7^{b}	2958.7^{ab}	0.48^{cd}	1.32	1.63^{bc}	4.43	0.48^{ab}	0.32
Metolachlor + atrazine	1.33 + 0.67	820.2^{b}	2863.0^{ab}	0.36^{c}	1.27	1.26^{c}	3.90	0.46^{ab}	0.36
Metolachlor + metobromuron	1.00 + 1.00	1887.5^{a}	4726.8^{a}	0.87^{ab}	2.10	2.92^{ab}	7.35	0.50^{ab}	0.40
Metolachlor + metobromuron	1.50 + 1.50	1204.8^{ab}	4533.4^{ab}	0.49^{bcd}	2.02	2.29^{abc}	7.00	0.51^{ab}	0.41
Metolachlor + linuron	1.00 + 0.50	1175.1^{b}	2774.4^{ab}	0.52^{bcd}	1.23	1.55^{bc}	3.57	0.40^{b}	0.32
Metolachlor + linuron	1.50 + 0.75	1280.0^{ab}	4275.2^{ab}	0.57^{abcd}	1.90	1.94^{abc}	7.54	0.50^{ab}	0.45
Metolachlor + prometryne	1.00 + 1.00	1496.2^{ab}	2910.3^{ab}	0.67^{abcd}	1.29	2.10^{abc}	4.55	0.48^{ab}	0.30
Metolachlor + prometryne	1.50 + 1.50	1672.3^{a}	4417.5^{a}	0.74^{abc}	1.96	2.31^{abc}	7.68	0.49^{ab}	0.40
Metolachlor + metribuzin	1.00 + 0.25	2046.4^{a}	4943.0^{ab}	0.91^{a}	2.20	3.23^{a}	7.89	0.56^{ab}	0.39
Metolachlor + metribuzin	1.50 + 0.50	721.7^{b}	2420.4^{ab}	0.32^{c}	1.08	1.22^{c}	4.17	0.42^{ab}	0.41
Hoe-weeding at 3 and 6 WAP	-	1640.4^{a}	3878.3^{a}	0.84^{abc}	1.72	2.70^{abc}	6.10	0.62^{a}	0.35
Hoe-weeding at 3, 6 and 9 WAP	-	1952.4^{a}	4863.6^{a}	0.73^{abc}	2.16	2.63^{abc}	7.10	0.50^{ab}	0.36
Untreated check	-	1062.9^{b}	2094.7^{b}	0.47^{cd}	0.93	1.83^{abc}	3.61	0.44^{ab}	0.26
SE±	-	366.28	2214.05	0.33	0.48	0.62	2.04	0.09	0.08

[1]All herbicide treatments were applied pre-emergence, a day after planting. [2]WAP = Weeks after planting.

[3]Values not significantly different from each other using Duncan Multiple Range Test (DMRT).

*Means followed by the same letter(s) within a column are not significantly different using Duncan's Multiple Range Test

a.i./ha and metribuzin at 1.50 + 0.50 kg a.i./ha and the untreated check. At 9 weeks after planting, only mixtures of metolachlor with metobromuron at 1.00 + 1.00 kg a.i./ha, metribuzin at 1.00 + 0.25 kg a.i./ha and the hoe-weeded control resulted in significantly higher leaf area and leaf area index per plant than the untreated check. Unchecked weed growth reduced leaf area by 48.4% and 68.0% at 6 and 9 weeks after planting respectively (Table 15).

As observed with leaf area, mixtures of metolachlor with metobromuron at 1.00 + 1.00 and metribuzin at 1.00 + 0.25 kg a.i./ha resulted in significantly higher leaf area index than mixtures of metolachlor with ametryne at 1.50 + 1.00 kg a.i./ha, atrazine at both rates and metribuzin at 1.00 + 0.50 kg a.i./ha, and the untreated check. Mixtures of metolachlor with metobromuron at 1.50 + 1.50 kg a.i./ha and linuron at 1.00 + 0.50 kg a.i./ha also resulted in lower leaf area index than the highest obtained with metolachlor plus metribuzin at 1.00 + 0.25 kg a.i./ha.

4.2.7 Crop growth rate and relative growth rate

The effect of weed control treatments on the crop growth and relative growth rates of potato was significant at 6 weeks after planting (Table 15). Among the herbicide treatments, only metolachlor plus linuron at 1.00 + 0.50 kg a.i./ha resulted in

significantly lower relative growth rate than the highest obtained with the hoe-weeded controls.

Metolachlor plus metribuzin at 1.00 + 0.25 kg a.i./ha resulted in significantly higher crop growth rate than mixtures of metolachlor with ametryne at 1.50 + 1.00 kg a.i./ha, atrazine at both rates, linuron at 1.00 + 0.50 kg a.i./ha and metribuzin at 1.00 + 0.25 kg a.i./ha. The other herbicide treatments had comparable crop growth rate to the hoe-weeded control.

4.2.8 Haulm dry matter production

Haulm dry matter production was only significantly affected by weed control treatments at 6 weeks after planting as shown in Table 15.

Metolachlor plus metobromuron at 1.00 + 1.00 kg a.i./ha had significantly higher haulm dry matter production than metolachlor plus ametryne at 1.50 + 1.00 kg a.i./ha, atrazine at both rates, linuron at 1.00 + 0.50 kg a.i./ha and metribuzin at 1.50 + 0.50 kg a.i./ha. Mixtures of metolachlor with metribuzin at 1.00 + 0.25 kg a.i./ha also resulted in significantly higher haulm dry matter production than those of metolachlor with atrazine at 1.33 + 0.67 kg a.i./ha and metribuzin at 1.50 + 0.50 kg a.i./ha. While mixture of metolachlor plus atrazine at 1.33 + 0.067 kg a.i./ha had comparable haulm dry matter production with that of the hoe-weeded crop,

Table 16: Effect of weed control treatments on the stand count, haulm dry matter production, pre-harvest tuber dry weight and number per plant of potato in 1985 wet season, at Samaru.

Treatments Herbicides[1]	Rate kg a.i./ha	Crop stand count per net plot(%) at		Tuber dry weight (gm) per plant		Number of tubers per plant		Haulm dry matter production (gm)	
		2 WAP	Harvest	6 WAP	9 WAP	6 WAP[2]	9 WAP	6 WAP	9 WAP
Metolachlor + ametryne	1.00 + 0.75	89.44[3]	92.91[3]	11.07^{ab*}	31.87^{abc}	6.67^{ab}	9.67^{ab}	7.6^{abc}	25.1[3]
Metolachlor + ametryne	1.50 + 1.00	72.80	87.36	9.73^{ab}	30.53^{abc}	4.00^{e}	6.67^{ab}	6.2^{bcd}	24.4
Metolachlor + atrazine	1.33 + 0.67	86.67	90.83	10.15^{ab}	21.63^{cd}	4.67^{de}	7.00^{ab}	5.5^{cd}	17.2
Metolachlor + atrazine	2.00 + 1.00	79.04	88.05	7.27^{bcd}	23.66^{bcd}	4.00^{e}	6.67^{ab}	6.6^{bcd}	20.
Metolachlor + metobromuron	1.00 + 1.00	85.28	88.75	12.95^{a}	38.39^{a}	5.80^{bcd}	8.33^{ab}	11.4^{a}	32.0
Metolachlor + metobromuron	1.50 + 1.50	83.26	90.83	9.77^{ab}	28.60^{abc}	4.33^{cde}	6.33^{ab}	8.7^{abcd}	29.7
Metolachlor + linuron	1.00 + 0.50	67.95	82.51	5.61^{cd}	13.41^{d}	4.00^{e}	5.67^{b}	6.6^{bcd}	17.0
Metolachlor + linuron	1.50 + 0.75	73.49	85.97	10.41^{ab}	33.00^{ab}	5.67^{bcd}	8.00^{ab}	7.5^{abcd}	30.1
Metolachlor + prometryne	1.00 + 1.00	87.36	90.13	8.37^{bcd}	23.80^{bcd}	7.67^{a}	13.00^{a}	8.2^{abcd}	21.9
Metolachlor + prometryne	1.50 + 1.50	82.51	89.44	9.31^{ab}	28.08^{abc}	4.67^{de}	6.00^{b}	9.0^{abcd}	34.4
Metolachlor + metribuzin	1.00 + 0.25	82.51	91.51	10.43^{ab}	37.87^{a}	5.60^{ab}	11.33^{ab}	10.7^{ab}	17.6
Metolachlor + metribuzin	1.50 + 0.50	81.12	87.36	5.28^{d}	22.71^{bcd}	4.00^{e}	6.00^{b}	5.00^{d}	17.6
Hoe-weeding at 3 and 6 WAP	-	68.71	79.00	8.81^{bcd}	28.60^{abc}	6.33^{ab}	8.00^{ab}	9.5^{abcd}	27.8
Hoe-weeding at 3, 6 and 9 WAP	-	90.13	92.90	9.14^{bc}	29.79^{abc}	6.00^{bc}	10.00^{ab}	10.1^{abc}	32.1
Untreated check	-	90.13	92.91	6.1^{cd}	19.75^{cd}	5.00^{cd}	5.67^{b}	7.5^{abcd}	18.3
SE±		9.325	5.320	1.587	0.752	5.425	2.88	2.311	8.900

[1]All herbicide treatments were applied pre-emergence, a day after planting. [2]WAP = Weeks after planting.

[3]Values not significantly different from each other. *Means followed by the same letter(s) within a column are not significantly different using Duncan's Multiple Range Test (DMR

it was significantly higher than that of metolachlor plus metribuzin at 1.50 + 0.50 kg a.i./ha.

4.2.9 Pre-harvest tuber production

Tuberization was significantly affected by weed control treatments as reflected by number of tubers per plant and tuber dry matter production per plant at 6 and 9 weeks after planting (Table 16).

At 6 weeks after planting, both rates of mixture of metolachlor with ametryne and metobromuron, and mixtures of metolachlor with linuron at 1.50 + 0.75 kg a.i./ha and metribuzin at 1.00 + 0.25 kg a.i./ha resulted in higher tuber dry matter production per plant than the untreated check. Tuber dry matter of metolachlor plus metobromuron at 1.00 + 1.00 kg a.i./ha was significantly higher than those of the hoe-weeded controls. Only mixtures of metolachlor with prometryne at 1.00 + 1.00 kg a.i./ha and ametryne at 1.00 + 0.75 kg a.i./ha and hoe-weeded control had higher tuber number than the untreated check. High rates of the mixture of metolachlor with ametryne, atrazine and metribuzin and metolachlor plus linuron at 1.00 + 0.50 kg a.i./ha resulted in significantly lower tuber number than the untreated check. These herbicides and mixtures of metolachlor with atrazine at 1.33 + 0.67 kg a.i./ha and prometryne at 1.50 + 1.50 kg a.i./ha also resulted

in lower tuber weight compered with the hoe-weeded controls (Table 16).

At 9 weeks after planting, mixtures of metolachlor with metobromuron at 1.00 + 1.00 kg a.i./ha, linuron at 1.50 + 0.75 kg a.i./ha and metribuzin at 1.00 + 0.25 kg a.i./ha resulted in significantly higher tuber dry matter production per plant than the untreated check. Tuber dry matter per plant of plots treated with mixtures of metolachlor with linuron at 1.00 + 0.5 kg a.i./ha, prometryne at 1.00 + 1.00 kg a.i./ha, metribuzin at 1.50 + 0.5 kg a.i./ha and atrazine at both rates were lower than the highest value obtained at this stage. Only metolachlor plus prometryne at 1.00 + 1.00 kg a.i./ha resulted in higher tuber number than the untreated check. The number of tubers produced on plots treated with mixtures of metolachlor with linuron at 1.00 + 0.50 kg a.i./ha, prometryne at 1.50 + 1.50 kg a.i./ha and metribuzin at 1.50 + 0.50 kg a.i./ha were however lower than that obtained with metolachlor plus prometryne at 1.00 + 1.00 kg a.i./ha. (Table 16).

4.2.10 Effect of weed control treatments on potato number and yield at harvest

At harvest, potato tubers were graded into small-sized, medium-sized and large-sized as reported for the weed interference trial. The weed control treatments had significant effect on the numbers and

Table 17: Effect of weed control treatments on yield of various sizes and number of potato at harvest in 1985 wet seasor, at Samaru.

Treatments Herbicides[1]	Rate kg a.i./ha	Total tuber yield t/ha	Total tuber number/ha (x 1000)	Tuber yield (t/ha) Large-sized	Medium-sized	Small sized	Tuber number per hectare (x 1000) Large-sized	Medium-sized	Small-sized
Metolachlor + ametryne	1.00 + 0.75	11.31^{abcde}	518.5^{b}	2.19^{ab}	6.88^{bcd}	2.24^{bcde}	27.8^{ab}	165.8^{bc}	324.9^{a}
Metolachlor + ametryne	1.50 + 1.00	12.87^{abcd}	554.6^{ab}	2.58^{ab}	7.68^{bcd}	2.61^{bcd}	32.4^{ab}	188.7^{bc}	333.5^{a}
Metolachlor + atrazine	1.33 + 0.67	9.86^{cde}	497.2^{ab}	2.05^{ab}	5.53^{bcd}	2.28^{bcde}	22.2^{ab}	153.7^{bc}	321.3^{a}
Metolachlor + atrazine	2.00 + 1.00	12.20^{abcde}	509.3^{ab}	3.42^{a}	5.85^{bcd}	2.93^{bc}	39.8^{ab}	162.0^{bc}	307.4^{a}
Metolachlor + metobromuron	1.00 + 1.00	13.80^{abcd}	560.2^{ab}	4.03^{a}	7.98^{abcd}	1.79^{cde}	47.2^{a}	216.7^{bc}	351.0^{a}
Metolachlor + metobromuron	1.50 + 1.50	13.12^{abcd}	557.4^{ab}	3.50^{a}	7.28^{bcd}	2.34^{bcde}	38.9^{ab}	206.5^{bc}	312.0
Metolachlor + linuron	1.00 + 0.50	8.11^{de}	421.3^{b}	1.93^{ab}	4.26^{d}	1.92^{cde}	21.0^{ab}	138.9^{c}	216.5
Metolachlor + linuron	1.50 + 0.75	11.87^{abcde}	459.3^{b}	2.80^{ab}	7.67^{bcd}	1.40^{de}	30.5^{ab}	204.7^{bc}	224.1
Metolachlor + prometryne	1.00 + 1.00	13.04^{abcd}	551.1^{ab}	3.30^{a}	7.53^{bcd}	2.21^{bcde}	36.1^{ab}	310.2^{bc}	304.7
Metolachlor + prometryne	1.50 + 1.50	13.35^{abcd}	536.1^{ab}	3.01^{a}	8.07^{abcd}	2.27^{bcde}	31.5^{ab}	214.8^{bc}	289.6
Metolachlor + metribuzin	1.00 + 0.25	16.11^{ab}	633.3^{a}	3.21^{a}	8.68^{ab}	4.22^{a}	34.3^{ab}	225.9^{b}	373.
Metolachlor + metribuzin	1.50 + 0.50	10.48^{bcde}	423.1^{b}	2.50^{ab}	6.39^{bcd}	1.59^{de}	27.0^{ab}	183.4^{bc}	212.
Hoe-weeding at 3 and 6 WAP	-	14.59^{abc}	579.6^{ab}	2.95^{a}	8.39^{abc}	3.25^{ab}	32.4^{ab}	342.6^{a}	204.
Hoe-weeding at 3, 6 and 9 WAP	-	17.45^{a}	603.6^{ab}	3.36^{a}	11.58^{a}	2.51^{bcde}	36.1^{ab}	405.6^{a}	161.
Untreated	-	6.31^{e}	374.1^{c}	0.32^{b}	4.78^{cd}	1.21^{e}	5.6^{b}	155.6^{bc}	213.
$SE\pm$	-	2.61	81.67	1.10	1.61	0.56	14.50	42.58	70

[1]All herbicide treatments were applied Pre-emergence, a day after planting. WAP = Weeks after planting.

*Means followed by the same letter(s) within a column are not significantly different using Duncan's Multiple Range Tes
NS = Not significant.

weights of various sizes of potato tubers (Table 17).

Number and yield of small-sized tubers: Metolachlor plus metribuzin at 1.00 + 0.25 kg a.i./ha resulted in the highest number and weight of small sized tubers. Among the weed control treatments hoe-weeding thrice resulted in lower small-sized tuber number than the highest indicated. In contrast, three hoe-weeding resulted in comparable tuber weight to that of metolachlor plus metribuzin at 1.00 + 0.25 kg a.i./ha. Mixtures of metolachlor with metobromuron at 1.00 + 1.00 kg a.i./ha and linuron at both rates however resulted in lower small sized tuber weight than best herbicide treatment (Table 17).

Number and yield of medium-sized tubers: The hoe-weeded controls resulted in higher tuber number than all the other weed control treatments including the untreated check. Metolachlor plus metribuzin at 1.00 + 0.25 kg a.i./ha however resulted in higher medium sized tuber number than metolachlor plus linuron at 1.00 + 0.50 kg a.i./ha. Mixtures of metolachlor with metobromuron at 1.00 + 1.00 kg a.i./ha, prometryne at 1.50 + 1.50 kg a.i./ha and metribuzin at 1.00 + 0.25 kg a.i./ha resulted in comparable medium sized tuber weight to the three hoe-weedings, while all the other herbicide treatments and the untreated check were significantly lower. Medium sized tubers with metolachlor plus linuron at 1.00 + 0.50 kg a.i./ha

was also lower than that of two hoe-weedings (Table 17).

Number and yield of large-sized tubers: Among the weed control treatments, only metolachlor plus metobromuron at 1.00 + 1.00 kg a.i./ha resulted in significantly higher number of large sized tubers than the untreated check. However, mixtures of metolachlor with atrazine at 2.00 + 1.00 kg a.i./ha, metobromuron and prometryne each at both rates, and metribuzin at 1.00 + 0.25 kg a.i./ha and the hoe-weedings resulted in higher large-sized tuber weight than the untreated check.

Among the weed control treatments, metolachlor + metribuzin at 1.00 + 0.25 kg a.i./ha had significantly higher yields of large-sized, medium-sized and small-sized tubers than the untreated control. In addition to the hoe-weeded controls, metolachlor + metobromuron and metolachlor + prometryne at both rates, metolachlor + atrazine at 2.00 + 1.00 kg a.i./ha also resulted in higher large-sized tuber yield than the untreated check. In addition to metolachlor + metribuzin at 1.00 + 0.25 kg a.i./ha, two hoe-weedings and mixtures of metolachlor with atrazine and ametryne at 1.50 + 1.00 kg a.i./ha and 2.00 + 1.00 kg a.i./ha respectively resulted in significantly higher small-sized tuber than the untreated check.

Total number and yield of potato: All the weed control treatments resulted in significantly higher total tuber number compared with the untreated check. The highest number of tubers was obtained with metolachlor plus metribuzin at 1.00 + 0.25 kg a.i./ha which was significantly higher than that of its high rate and metolachlor plus linuron at both rates; the other weed control treatments were however comparable in number. Mixtures of metolachlor with ametryne at 1.5 + 1.0 kg a.i./ha, metobromuron and prometryne each at both rates and metribuzin at 1.00 + 0.25 kg a.i./ha resulted in comparable total tuber yield to the hoe-weeded controls and higher than the untreated check. In addition, metolachlor plus metribuzin at 1.00 + 0.25 kg a.i./ha resulted in significantly higher tuber yield than mixtures of metolachlor with atrazine at 1.33 + 0.67 kg a.i./ha and linuron at 1.00 + 0.50 kg a.i./ha (Table 17).

The highest tuber yield, 16.11 t/ha, obtained with herbicide treatment was about 92.3% of the better hoe-weeded control. Uncontrolled weed growth throughout the crop life cycle resulted in 40.9% and 63.8% reduction in the total number and total yield of potato respectively compared with the best treatment.

Table 18: Correlation between crop growth, parameters, yield, weed cover and weed dry matter production affected by herbicide treatments in potato 'Greta' in 1985 wet season at Samaru.

	Crop Growth						Yield		Wee
	Crop Vigour 9 WAP	Plant height 6 WAP	Dry weight of leaves per plant 6 WAP	Number of leaves per plant 6 WAP	Tuber dry wt per plant 6 WAP	Tuber No per plant 6 WAP	Total tuber yield	Total tuber No at harvest	6
Crop Vigour Score 9 WAP[1]	1.000								
Plant height 6 WAP	0.676	1.000							
Leaves dry weight per plant 6 WAP	0.725	0.574	1.000						
Number of leaves per plant 6 WAP	0.212	0.200	0.286	1.000					
Tuber dry weight per plant 6 WAP	0.621	0.680	0.385	0.272	1.000				
Tuber No per plant 6 WAP	0.233	0.145	0.302	0.220	0.292	1.000			
Total Tuber Yield	0.888	0.646	0.737	0.167	0.510	0.303	1.000		
Total tuber No at harvest	0.810	0.626	0.608	0.161	0.614	0.269	0.803	1.000	
Weed cover score 6 WAP	-0.481	-0.196	-0.278	-0.163	-0.408	0.05	-0.472	-0.474	1
Weed cover score at harvest	-0.591	-0.168	-0.285	-0.126	-0.302	-0.097	-0.611	-0.484	0
Total weed dry weight	-0.579	-0.208	-0.147	-0.072	-0.378	-0.103	-0.596	-0.487	0

All values above 0.296 are significant at 5% DF.

[1] Weeks after planting.

[redacted]

4.2.11 Relationship between Greta growth parameters, yield, weed cover score and weed dry matter production as affected by weed control treatments

Total potato yield was strongly correlated with the total potato number at harvest. Total number and yield of potato at harvest were positively correlated with crop vigour score, plant height, dry weight of leaves per plant, number and tuber dry matter production at 6 weeks after planting. The total number and yield of potato tubers were also negatively correlated with weed cover score and dry matter production at harvest (Table 18).

Plant height at 6 weeks after planting was positively correlated with dry weight of leaves and tubers at 6 weeks after planting but not correlated with any weed parameter (Table 18).

Leaf dry matter production per plant at 6 weeks after planting was positively correlated with tuber dry matter production at 6 weeks after planting; $r = 0.302$ and 0.385 for tuber number and dry matter of tubers per plant at 6 weeks after planting, respectively. Number of leaves per plant at 6 weeks after planting in this experiment was however not significantly correlated with any parameter.

Tuber dry matter production per plant at 6 weeks after planting was highly negatively correlated with all the weed parameters (Table 18).

Table 19: Effect of weed control treatments on soluble carbohydrate and crude protein content of potato tubers in 1985 wet season, at Samaru.

Treatments Herbicides	Rate kg a.i./ha	Soluble Carbohydrate content at harvest (%)	Crude protein content of potato at harvest (%)
Metolachlor + Ametryne	1.00 + 0.75	0.343^{e*}	2.04^{c}
Metolachlor + Ametryne	1.50 + 1.00	0.575^{cd}	2.348^{bc}
Metolachlor + Atrazine	1.33 + 0.67	0.272^{ef}	2.203^{bc}
Metolachlor + Atrazine	2.00 + 1.00	0.727^{ab}	2.291^{bc}
Metolachlor + Metobromuron	1.00 + 1.00	0.856^{a}	2.279^{bc}
Metolachlor + Metobromuron	1.50 + 1.50	0.561^{cd}	2.260^{bc}
Metolachlor + Linuron	1.00 + 0.50	0.337^{e}	1.520^{cd}
Metolachlor + Linuron	1.50 + 0.75	0.527^{cd}	2.29^{c}
Metolachlor + Prometryne	1.00 + 1.00	0.589^{cd}	2.103^{c}
Metolachlor + Prometryne	1.50 + 1.50	0.657^{bc}	2.085^{c}
Metolachlor + Metribuzine	1.00 + 0.25	0.842^{ab}	2.951^{a}
Metolachlor + Metribuzine	1.50 + 0.50	0.648^{de}	1.836^{c}
Hoe-weeding at 3, and 6 WAP[1]	-	0.807^{ab}	2.647^{abc}
Hoe-weeding at 3, 6 and 9 WAP	-	0.687^{bc}	2.843^{ab}
Untreated check	-	0.137^{ef}	1.284^{d}
SE±		0.161	0.529

[1]Weeks after planting

*Means followed by the same letter(s) within a column are not significantly different using Duncan's Multiple Range Test (DMRT).

Weed cover score at 4 weeks after planting has significant positive correlation with weed cover score and weed dry matter production at harvest both of which are also highly positively correlated (Table 18).

4.2.12 Effect of weed control treatments on the soluble carbohydrate and crude protein content of potato tuber

Table 19 shows that soluble carbohydrate and crude protein content of the tuber of potato, Greta, were significantly affected by weed control treatments.

Mixtures of metolachlor with metribuzin at 1.50 + 0.50 kg a.i./ha, linuron at 1.00 + 0.50 kg a.i./ha, atrazine at 1.33 + 0.67 kg a.i./ha and the untreated check resulted in significantly lower soluble carbohydrate content than all the other weed control treatments. However, metolachlor plus metribuzin, prometryne, metobromuron and atrazine at 1.00 + 0.25 kg a.i./ha, 1.50 + 1.50 kg a.i./ha, 1.00 + 1.00 kg a.i./ha, and 2.00 + 1.00 kg a.i./ha respectively gave tuber soluble carbohydrate content that were comparable to that of the better hoe-weeded control (Table 19).

The untreated check had lower crude protein content of tuber than all the herbicide treatments except metolachlor plus linuron at 1.00 + 0.50 kg a.i./ha. Metolachlor plus metribuzin at 1.00 + 0.25 kg a.i./ha had higher tuber crude protein content than all the other herbicide treatments but comparable to the

hoe-weeded controls. (Table 19). In this study unchecked weed growth throughout the crop life-cycle caused about 84% and 56.5% reduction in soluble carbohydrate and crude protein content of potato tubers respectively.

Chapter 5

DISCUSSION

In this study, the mean potato tuber yields of 11.94 and 9.31 tonnes per hectare obtained in the competition trial with varieties Greta and B7906-I respectively (Table 9) were lower than about 26.52 t/ha reported on Jos Plateau of Nigeria in the same year by Ifenkwe (1985). A maximum of 17.5 tonnes per hectare was however obtained with Greta in the weed control trial during the study. This could partly be attributed to various environmental factors viz low temperature of 12° to 18°C, low relative humidity and evenly distributed rainfall of Jos Plateau located on high altitude apparantly favoured high tuberization hence tuber yield. In contrast, the higher mean temperature and humidity at Zaria (Table 2) probably encouraged more vegetative growth to the detriment of tuberization in agreement with the reports of Kay (1973), Beukema et al. (1979), Harmsworth et al. (1980), and Mbah (1985). In addition, high foliar disease incidence, inspite of application of Diethane M45, a fungicide, probably contributed to the low potato yield obtained in this investigation. The main disease, leaf blight caused by (Phytophthora infestans) was however observed to be more prevalent on B7906-I and could not be effectively controlled because of the

delay in the commencement of the application of the fungicide at 4 weeks after planting and the high humidity during the growing season.

5.1 Effect of Varieties and Period of Weed Interference on the Growth and Yield of Potato

Despite the fact that both varieties were on the field for the same length of time, obvious differences in their growth and subsequent tuber yields were observed. While variety B7906-I was initially faster growing than Greta until 6 WAP, the latter subsequently exhibited greater growth vigour until harvest as reflected in crop vigour score, crop height, leaf dry weight, leaf area, leaf area index, relative and crop growth rates and haulm dry matter production. The result on tuber initiation as reflected in the weight and number of tubers at 9 weeks after planting and subsequent tuber yield further confirms the superiority of Greta over B7906-I. The initial faster growth exhibited by B7906-I may be attributed to earlier emergence as reflected in higher stand count at 2 weeks after planting than Greta. The higher potato leaf blight disease incidence observed on B7906-I might be partly responsible for lower tuber yields obtained with this variety. The differences in the maturity period indicated by Ifenkwe (1985) were not apparent in this trial since the two varieties were mature enough for harvesting at about the same time. The high foliar disease observed despite spraying might have marred the

short difference in period of maturity between the two varieties.

Provided weeds were subsequently removed, infestation for the first 3 weeks after planting did not have any adverse effect on crop growth as reflected in crop vigour score, number of leaves, leaf dry weight and crop height (Table 6) and the consequent tuber yield at harvest (Table 9). This was probably because the weeds were not yet well established to compete seriously with the crop at this stage. In addition, since the crop took over two weeks for full emergence, it only had less than one week exposure to weed competition in this treatment which was obviously inadequate to have any adverse effect on the crop. This result is in accord with the report of Singh (1982) who observed that initial weed infestation until three weeks after planting had no significant effect on potato growth and yield. However, infestation for a further three weeks i.e. six weeks after planting resulted in significantly lower vigour score and leaf dry matter (Table 6), leaf area, leaf area index, haulm dry matter production, relative and crop growth rates (Table 7) and number and yield of potato tuber at harvest compared with the highest values obtained (Table 9). Similarly, weed association with the crop until 9 WAP produced significantly lower crop growth parameters viz crop vigour score and leaf dry matter per plant (Table 6), leaf area, leaf area index, haulm

dry matter production, relative and crop growth rates (Table 7) and tuber yield (Table 9) compared with infestation until 3 WAP. Once infested by weeds until 9 WAP, subsequent weed removal did not obviate reduction in tuber yield compared with weed infestation until harvest, although significant difference was observed between infestation until 9 WAP and harvest in tuber number (Table 9).

In this study, weed association with the crop throughout its life cycle caused about 71.5% reduction in total tuber yield compared with the best obtained with the crop kept weed-free throughout (Table 9). Isleib (1960) observed that weeds when allowed to compete with potato throughout its life-cycle also reduced tuber yield by 70%. Between 35% and 81% losses in potato tuber yield due to unchecked weed growth throughout the crop life-cycle have also been reported by various workers (Dallyn et al., 1970, Zughir et al., 1974; Chandra-Singh and Rao, 1976). On Jos Plateau, Nigeria, only about 19.7% potato yield reduction occurred when weeds were allowed to compete with the crop until harvest (Ifenkwe, 1985). This lower yield loss produced at Jos was probably due to low weed infestation during the cropping season as also observed by Dowson (1970), Kirt et al. (1972), Evera'erts et al. (1977) and Kusome (1980).

Crop kept weed-free for 3 weeks and 6 weeks after planting had significantly lower crop vigour scores until harvest, leaf dry weight per plant (Table 6), leaf area, leaf area index, haulm dry matter production and crop growth rate at 9 WAP (Table 7) and potato tuber yields at harvest compared with the highest values obtained (Table 9). Crop kept weed-free until 3 WAP also had lower tuber yield than that kept weed-free until 9 WAP. This suggests that weed removal for the first 3 and 6 weeks after planting were inadequate for optimum yield to be achieved. In order to obtain yields comparable to those of weed-free controls, it was required to keep the crop weed-free for a further 3 weeks beyond the first 6 weeks after planting.

In this investigation, the highest gain in potato yield of 0.62 t/ha per week was obtained when the crop was kept weed-free for a further 3 weeks beyond the first 6 WAP. Similarly, the highest reduction in potato tuber yield of 1.09 t/ha per week occurred when the crop was infested for a further 3 weeks beyond the initial 6 weeks after planting (Table 9). The relatively long weed-free period requirement to achieve maximum yield was due to the preponderance of late emerging weeds at the site of the trial, such that early removal was inadequate to obviate their effects. During the weeding operation at the later stage of crop growth, earthing-up also occurred which ensured proper coverage of the initiated potato tubers, and thereby encouraging

their enlargement. Gupta et al. (1974) had earlier reported that the exposure of the tubers (sink) to light would retard tuberization even when the condition of the assimilate (leaves) is favourable.

The production of large-sized and medium-sized tubers in response to weed-infestation was consistently similar to that observed with the total tuber yields, while that of the small-sized tuber was inconsistent. Higher yields of small-sized tuber occurred when the crops were exposed initially to weed infestation until 6 weeks after planting but significantly lower yields with further infestation until 9 WAP and more. This may be attributed to the fact that longer periods of infestation, upto a point, tend to encourage small-sized tuber formation at the expense of larger-sized tubers until 6 WAP. However, with further infestation until 9 WAP and more, significant reduction in all sizes of tubers occurred (Table 9 and Figure 4).

The interaction of variety and period of weed interference was only significant on potato tuber yield (Table 10). It was apparent that in both varieties, crop kept weed-free initially for 3 WAP only and those weed-infested until 6 WAP and more had significantly lower yields compared with those kept weed-free until harvest; crop kept weed-free until 6 WAP only also had lower yields in the case of Greta. In addition, weed

removal after infestation until 9 weeks after planting only resulted in significant tuber yield increase compared with infestation until harvest in B7906-I (Table 10). In figure 1, it was estimated that for 10% losses in tuber yield in variety Greta, the crop should be kept weed-free from 16 to 53 days after planting. With this variety, it was required to keep the crop weed-free throughout its life-cycle in order to obtain maximum potato tuber yield. However, in variety B7906-I, in order to obtain maximum yield and 10% yield reduction, the crop should be kept weed-free until 50 days after planting and from 26 to 39 days after planting respectively (Fig.1). Similarly as indicated on Fig.2, about 10% yield losses in large sized tubers of Greta and B7906-I would occur if the varieties were kept weed-free from 11 days after planting to harvest and the time of planting to 40 days after planting respectively. Keeping varieties Greta and B7906-I weed-free respectively from 17 to 42 days after planting and 30 to 42 days after planting would cause about 10% reduction in medium-sized tuber production. Fig. 4 has also shown that about 10% losses in yield for Greta and B7906-I small-sized tubers occurred when the crops were infested from 12 to 55 days after planting and from 36 to 60 days after planting respectively. Both Adigun (1984) and Bakut (1985) have similarly estimated weed-free

requirements for pepper and pepper/maize mixture in a similar experiment using quartic regression equation to determine values for the curve. With adequate weed control, Greta had higher tuber yields than B7906-I as reflected in the yield of the crop kept weed-free initially for various periods and those infested for 3 weeks only. Sweet et al. (1974), Ahmed (1980a), Ahmed (1980b) and Mbah (1985) also reported differential response to weed competition and agronomic practices by potato varieties.

The highest increase in tuber yields of 0.67 and 1.00 t/ha per week each for B7906-I and Greta occurred when the crops were kept weed-free for a further 3 weeks beyond the first 3 weeks and 6 weeks after planting respectively (Table 10). Similarly the highest reduction in tuber yields of 1.60 t/ha and 1.83 t/ha per week each for B7906-I and Greta were obtained with the crops' exposure to weeds for a further 3 weeks beyond the initial infestation for 6 weeks (Table 10). This suggests that the critical period of weed competition for variety B7906-I and Greta were between 3 weeks and 9 weeks after planting and 6 and 9 weeks after planting respectively. It was apparent that B7906-I was more susceptible to early weed-infestation than Greta because of its slight earliness and more rapid growth during the early stage of growth. This is

manifested in the crop parameter taken at 6 weeks after planting. Once infested until 9 WAP, subsequent weed removal did not obviate the reduction in yield caused by weed competition with the variety Creta. These periods coincide with the period of rapid weed growth which was between 3 and 9 weeks after planting as reflected in the cumulative weed dry matter production(Table 6).

The most common weed species during this investigation included broad-leaved and grass weeds, such as, Portulaca oleraceae (L), Vernonia galamensis (cass) (less), Panicum maximum Jacos and Eleusine indica L. (Table 3). Table 6 reveals that the highest weekly decline in weed dry matter production of 1.37 t/ha occurred when the plots were kept weed-free for a further three weeks beyond the first 6 WAP, while the highest increase of 3.34 t/ha per week was obtained on the plots weed-infested for further 3 weeks beyond the initial 3 WAP. Also as shown in Table 6, plots kept weed-free for 3 weeks and 6 weeks after planting and those weed-infested for 6 WAP and more had significantly higher cumulative weed dry matter production than those kept weed-free throughout. This suggests that the critical period of rapid weed growth which was between 3 and 6 WAP coincided with the critical period of weed competition with the varieties. Saghir et al. (1974) had established the critical period of weed competition in potato to be between 6 weeks and 9 weeks after planting.

Work reported by Ifenkwe (1985) on Jos Plateau, Nigeria, also revealed that potato was most critically affected when allowed to be infested until 6 and 9 WAP and subsequently kept weed-free until harvest. Lagoke (1978) and Adigun (1984) had investigated the period of rapid weed growth to the critical period of weed competition with the crop.

5.2 Effect of Herbicide Treatments on Weed and Potato

All the weed control treatments significantly reduced weed cover score until harvest and weed dry matter production at harvest compared with the untreated check (Table 13). Among the herbicide treatments, mixtures of metolachlor with metobromuron at 1.00 + 1.00 and 1.50 + 1.50 kg a.i./ha, prometryne at 1.00 + 1.00 and 1.50 + 1.50 kg a.i./ha, metribuzin at 1.00 + 0.25 kg a.i./ha and ametryne at 1.50 + 1.00 a.i./ha resulted in comparable weed scores at 9 WAP, weed dry matter production (Table 13), crop vigour score at 6 WAP, number of leaves per plant, leaf area, leaf area index, relative and crop growth rates at 6 WAP (Table 15), potato tuber yield and number at harvest (Table 17) and tuber soluble carbohydrate and crude protein content (Table 19) to the hoe-weeded checks. Pre-emergence application of herbicide treatments such as, ametryne, prometryne, and metolachlor in potato were reported to combine selectivity with high tuber yields (Ramirez et al., 1970; Eddowas, 1971; Sarpel et al., 1971; Thomas,

1974; Alvarez, 1974; Fryer and Makepeace, 1977; Selleck, 1978; Murphy and Morrow, 1979 and Nwokocha et al., 1986). Rodriquez et al. (1982) also chieved effective weed control with high tuber yield and soluble carbohydrate with the pre-emergence application of ametryne at 3.2 kg a.i./ha.

Despite effective weed control (Table 12) metolachlor plus metribuzin at 1.50 + 0.50 kg a.i./ha caused significant depression in crop vigour score, leaf dry matter production (Table 14), leaf area, leaf area index, crop growth rate at 6 WAP (Table 15), soluble carbohydrate and crude protein content of tubers (Table 19) compared with the highest obtained in the trial due to phytotoxicity. This result is in agreement with work reported by Eue and Tietz (1970) who observed pre-emergence application of metribuzin at 3.0 kg a.i./ha to depress potato crop growth and yield. The failure of mixtures of metolachlor with ametryne at 1.00 + 0.75 kg a.i./ha and linuron at both rates to produce significantly higher tuber yields than the untreated check (Table 17) may be attributed to inadequate weed control by the treatments as reflected in the weed cover score and dry matter production (Table 13). Although metolachlor plus atrazine adequately controlled weeds (Table 13), only the higher rates resulted in comparable number and dry weight of leaves per plant at 6 WAP (Table 14), leaf area, relative growth

rate at 9 WAP (Table 15), and the consequent tuber yield to three hoe-weedings (Table 17). Unchecked weed growth throughout the crop life cycle in this trial caused about 63.8; 41.0, 84.0 and 56.6% reduction in the yield, number of tubers, soluble carbohydrate and crude protein content of tuber respectively compared with the highest value obtained in the trial.

Relative production of various sizes of tubers were affected by the weed control treatments (Table 17). Metolachlor plus metribuzin at 1.0 + 0.25 kg a.i./ha resulted in high yields of all grades of tubers. All the herbicide treatments resulted in large-sized tuber yields comparable to the three hoe-weedings, Metolachlor plus linuron at 1.00 + 0.50 kg a.i./ha however had significantly lower medium-sized tuber yield compared with metolachlor plus metribuzin at 1.00 + 0.25 kg a.i./ha while none of the other herbicide treatments had comparable small-sized tuber yields to the latter treatment (Table 17).

Earthing-up has been reported to encourage tuberization in potato (Gupta et al., 1974; Mbah, 1985). Since the herbicide treated plots in this investigation were not followed by supplementary hoe-weeding, the highest tuber yield obtained with the best herbicide treatment was slightly lower than that of the better hoe-weeded check, although not significant (Table 17).

Nwokocha et al. (1986) achieved more effective weed control with consequent higher potato tuber yield when metribuzin, metolachlor, alachlor and atrazine were not followed by supplementary hoe-weeding than hoe-weeded control. This may be attributed to the low weed infestation normally experienced with the May planting of potato on Jos Plateau, which further enhanced the effectiveness of herbicide treatments to control weeds. Lagoke, Sinha and Olaleye (1983) also observed that low temperature during the harmattan period improved the performance of herbicides on weed control in irrigated tomatoes in the Nigerian Sudan savanna. However, Spiridonov et al. (1969) reported that atrazine at 1.00 kg a.i./ha and 2.4 kg a.i./ha followed by supplementary hoe-weeding combined a season-long weed control with higher potato tuber yield than herbicide application alone. Adigun (1984) and Gwergwor (1985) also observed that supplementary hoe-weeding was important in chemical weed control programmes, if maximum yields were to be achieved. Hence promising herbicide treatments in this investigation especially metolachlor plus metribuzin at 1.00 + 0.25 kg a.i./ha which gave significantly higher small-sized tuber yield than all the other herbicides, could be followed by supplementary hoe-weeding at 6 WAP to coincide with the tuberization period and thereby enhance tuber enlargement with consequent high yield.

5.3 Correlation Between Crop Growth Parameter, Yield, Weed Cover Score and Dry Matter as Affected by Herbicide Treatments at Samaru.

Total potato yield was strongly correlated with total potato number at harvest (Table 18). Total number and yield of potato at harvest were positively correlated with crop vigour score, plant height, dry weight of leaves per plant, number and tuber dry matter production at 6 weeks after planting, and negatively with weed cover score and dry matter production at harvest (Table 18). In the study, the more vigorously growing variety appeared to give higher yield than less vigorously growing variety. Mazza (1983) also observed that potato yield correlated positively with crop dry matter production while Gautaney et al. (1983) reported strong correlation between potato tuber yield and stand count at harvest. Adigun (1984) and Gworgwor (1985) similarly reported negative correlation of weed dry matter production with crop yields.

Chapter 6

SUMMARY AND CONCLUSSIONS

Two field experiments were conducted during the 1985 wet season at Samaru in the northern Guinea savanna of Nigeria to study the effects of period of weed interference and weed control on Potato (Solanum tuberosum L.).

In the weed interference experiment, a factorial combination of two potato varieties, B7906-I and Greta, with eight periods of weed interference were laid out in a randomized complete block design and replicated three times. In one set of the treatments, plots were kept weed-free for 3, 6 and 9 weeks after planting and subsequently left unweeded until harvest. In the other set, weeds were allowed to compete with the crop for the corresponding periods and subsequently controlled until harvest. Two treatments of weed-free and weed-infestation throughout the crop growth period were also included as controls. Weeding operation was carried out with the traditional hand-hoe.

In the herbicide evaluation study, twelve herbicide treatments of six metolachlor-based mixtures at two rates were compared with two hoe-weeded controls and an untreated check. These treatments were laid out in a randomized complete block design and replicated three

The results obtained in this investigation indicated that potato varieties B7906-I and Greta were most critically affected by weed competition between 3 and 6 weeks after planting and 6 and 9 weeks after planting, respectively. Weed infestation for the first 3 weeks after planting did not have any adverse effect on the two potato varieties. However, once infested until 9 weeks after planting, subsequent weed removal did not obviate the reduction in yield caused by weed competition with the variety Greta. Keeping B7906-I and Greta weed-free until 6 and 9 WAP respectively resulted in yield comparable to the appropriate weed-free controls. It was however required to keep variety Greta weed-free throughout its life-cycle and B7906-I weed-free until 50 days after planting in order to obtain maximum potato tuber yields. With adequate weed control, Greta had significantly higher tuber yield than B7906-I as reflected in the yield of the crop kept weed-free initially for various periods and those infested for 3 weeks after planting only.

Among the herbicide mixtures tested on Greta, mixture of metolachlor with metribuzin at 1.00 + 0.25 kg a.i./ha, metobromuron and prometryne each at 1.00 + 1.00 and 1.50 + 1.50 kg a.i./ha and ametryne at 1.50 + 1.00 kg a.i./ha combined effective weed control with good crop growth and resulted in high tuber yields with high soluble carbohydrate and [illegible] protein that [illegible]

comparable to those of two and three hoe-weedings. Despite effective weed control, metolachlor plus metribuzin at 1.50 + 0.50 kg a.i./ha, it caused significant depression in crop vigour score, leaf dry matter production, leaf area, leaf area index, crop growth rate at 6 weeks after planting, soluble carbohydrate and crude protein content of tubers compared with the highest obtained in the trial due to phytotoxicity Although not significant, the potato tuber yield obtained with the best herbicide treatment was slightly lower than that of the two and three hoe-weeding checks, probably because of the need to earth-up for enhanced potato tuber enlargment and yield.

In this investigation, unchecked weed growth throughout the crop life-cycle significantly depressed crop vigour, leaf area, leaf area index, tuber soluble carbohydrate and crude protein and reduced crop yield by 71.0% and 63.8% compared with the appropriate best treatments in the weed competition and chemical weed control trials respectively.

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Appendix 1: Fitted values of total yield for Greta and B7906-I potato varieties at harvest as affected by period of weed interference at Samaru in 1985 wet season.

Period in	Initially weed free yields (t/h)		Initially weed infested yield (t/h)	
Weeks	B7906-I	Greta	B7906-I	Greta
0	4.5	6.2	11.9	17.7
3	7.6	9.8	11.7	15.3
6	11.6	15.0	9.6	10.4
9	12.4	17.0	5.8	4.8
12	11.5	16.7	3.3	3.8

Appendix 2: Values of regression coefficient for fitted curves on Greta and B7906-I potato tuber total yields.

	Initially weed free		Initially weed-infested	
	B7906-I	Greta	B7906-I	Greta
a	4.502	6.195	11.881	17.693
b_2	0.547	0.610	0.478	-0.327
b_3	-0.075	-0.077	-0.028	0.022
b_4	2.791	2.719	1.567	-2.632

Appendix 3: Fitted values of large-sized potato tuber yield for Greta and B7906-I varieties as affected by period of weed interference at harvest at Samaru in 1985 wet season.

Period in Weeks	Initially weed-free yields (t/h)		Initially Weed-infested yields (t/h)	
	B7906-I	Greta	B7906-I	Greta
0	-4.5	0.4	1.9	4.2
3	1.1	1.4	1.4	3.0
6	2.5	2.8	0.7	1.2
9	2.6	3.6	0.2	0.2
12	2.2	3.7	0.1	0.1

Appendix 4: Values of regression coefficient for fitted curves on Greta and B7906-I potato tuber large-sized yields.

	Initially weed-free		Initially Weed-infested	
	B7906-I	Greta	B7906-I	Greta
a	0.450	0.424	1.891	4.151
b_2	0.206	0.153	-0.076	0.024
b_3	-0.029	-0.018	0.009	-0.198
b_4	1.109	5.817	-2.737	-7.918

Appendix 5: Fitted values of medium-sized tubers yields for Greta and B7906-I varieties as affected by period of weed-interference at harvest at Samaru in 1985 wet season.

Period in Weeks	Initially Weed-free yield (t/h)		Initially Weed-infested yields (t/h)	
	B7906-I	Greta	B7906-I	Greta
0	3.3	5.1	8.2	11.2
3	5.0	7.2	7.8	9.7
6	7.3	10.1	6.1	6.6
9	8.1	11.0	3.6	3.9
12	8.0	10.6	2.1	2.8

Appendix 6: Values of regression coefficient for fitted curves on Greta and B7906-I potato tuber medium-sized yields.

	Initially Weed-free		Initially Weed-infested	
	B7906-I	Greta	B7906-I	Greta
a	3.253	5.074	8.220	11.241
b_2	0.285	0.371	-0.021	-0.219
b_3	-0.037	-0.049	-0.011	0.017
b_4	1.309	1.773	7.389	-3.001

Appendix 7: Fitted values of small-sized tuber yields for Greta and B7906-I varieties as affected by period of weed interference at harvest at Samaru in 1985 wet season.

Period in Weeks	Initially Weed-free yields (t/h)		Initially Weed-infested yields (t/h)	
	B7906-I	Greta	B7906-I	Greta
0	1.2	0.9	1.0	2.2
3	1.5	1.4	1.6	2.6
6	1.8	2.1	2.6	2.7
9	1.7	2.3	2.2	1.7
12	11.4	2.2	1.2	0.9

Appendix 8: Values of regression coefficient for fitted curves on Greta and B7906-I potato small-sized tuber yields.

	Initially Weed-free		Initially Weed-infested	
	B7906-I	Greta	B7906-I	Greta
a	0.453	0.859	1.325	2.171
b_2	-0.013	0.085	0.130	0.095
b_3	0.160	-0.011	-0.022	-0.019
b_4	-0.010	3.939	0.002	8.460

Appendix 9: Common and chemical names of the herbicides mentioned in the text.

Common names	Chemical names
Herbicides	
Ametryne	(2-(ethylamino)-4-(isopropylamino)-6-methylthio-S-triazine).
Atrazine	(2-chloro-4 (ethylamino)-6-isopropylamine)-S-triazine).
Prometryne	(2, 4-bis (isopropylamino)-6-methoxy-S-triazine).
Metribuzin	4-amino-6-tert-butyl-3(methylthio)-as-triazine-5(4H) one.
Metobromuron	2-(4-bromophenyl)-1-methoxy-1-methylurea.
Linuron	3-(3, 4-dichlorophenyl)-1-methylurea.
Metolachlor	2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl).

Appendix 10: Mean squares from analysis of variance for total potato yield and number, and yield of large-sized potato tubers as affected by period of weed interference at Samaru in 1985 wet season.

Source of variation	DF	Total tuber yield per hectare	Total tuber number per hectare	Yield of Large-sized tubers	Number of Large-size tuber per hectare
Replication	2	236859	945.75	50555.8	96.27
Variety	1	1.29043E+07**	11610.2**	1.25592E+06**	160.94
Treatment	7	1.06107E+07**	31059.2**	790790**	563.41
Treatment + Variety	7	901299*	3316.14	152357	68.82
Residual	30	335120	1927.77	105426	99.49
Total	47				

* F Value significant at 5% level of probability.
** F Value significant at 1% level of probability.

Appendix 11: Mean squares from analysis of variance for medium and small-sized grade potato tuber number and yields as affected by period of weed interference at harvest at Samaru in 1985 wet season.

Source of variance	DF	Medium-sized tubers		Small-sized tubers	
		Yield per hectare	Number per hectare	Yield per hectare	Number per hectare
Replication	2	910673	34021*	69483.3	59436*
Variety	1	5.37609E+06**	1582	125053*	14698
Treatments	7	4.14383E+06**	21535*	171460**	17737*
Treatrent x Variety	7	398257	1959	57881	8125
Residual	30	466242	5457	543141	11394
Total	47				

* F Value significant at 5% level of probability.

** F Value significant at 1% level of probability.

Appendix 12: Mean squares from analysis of variance for potato crop vigour score, at 6 and 9 WAP, plant height, leaf number and dry weight per plant at 6 weeks after planting as affected by period of weed interference at Samaru in 1985 wet season.

Source of Variation	DF	Crop Vigour Score 6 WAP	Crop Vigour Score 9 WAP	Plant height 9 WAP	Leaf number per plant at 9 WAP	Leaf dry weight per plant 9 WAP
Replication	2	1.703	1.609	517.938	708.396	24.381
Variety	1	26.255**	10.083**	3780.75**	2523**	330.225**
Treatment	7	4.035*	4.461*	354.226*	622.095*	94.065*
Treatment x Variety	7	1.303	0.190	228.893	189.857	5.226
Residual	30	1.348	0.582	121.293	267.507	7.029
Total	47					

* F Values significant at 5% level of probability

** F Values significant at 1% level of probability

WAP = Weeks after planting.

Appendix 13: Mean squares from analysis of variance for leaf area index, crop growth rate at 6 and 9 WAP, and haulm dry matter production at 6 WAP as affected by period of weed interference at Samaru in 1985 wet season.

Source of Variation	DF	Leaf area index		Growth rate		Haulm dry matter production
		6 WAP	9 WAP	6 WAP	9 WAP	6 WAP
Replication	2	0.114	0.283	0.748	0.04	19.348
Variety	1	0.295**	4.589**	1.428*	62.09**	68.144**
Treatment	7	0.070*	1.259*	1.672*	8.859*	15.858*
Treatment x Variety	7	0.0167	0.577	0.458	4.796	1.718
Residual	30	0.0236	0.133	0.488	1.418	3.274
Total	47	0.0391	0.467	0.618	4.261	6.818

* F Values significant at 5% level of probability

**F Values significant at 1% level of probability

WAP = Weeks after planting.

Appendix 14: Mean squares from analysis of variance for crop stand count at 2 WAP and harvest, tuber dry weight and number per plant at 9 weeks after planting as affected by period of weed interference at Samaru in 1985 wet season.

Source of Variation	DF	Crop Stand count %		Tuber dry weight	Tuber number per plant at
		2 WAP	At harvest	9 WAP	9 WAP
Replication	2	10.563	0.438	20.69	1.083
Variety	1	184.083*	2.083	535.34*	105.023**
Treatment	7	29.762	1.798	386.58*	13.664*
Treatment x Variety	7	29.893	4.083	46.47	7.735
Residual	30	10.34	2.371	63.23	8.283
Total	17				

* F values significant at 5% level of probability

** F values significant at 1% level of probability

W.P = Weeks after planting.

Appendix 15: Mean squares from analysis of variance for total potato tuber number and yield, and number and yield of large-sized Greta tubers, soluble carbohydrate and crude protein content as affected by herbicide treatments at Samaru in 1985 wet season.

Source of Variation	DF	Total tuber yield per hectare	Total number of tuber per hectare	Yield of large-sized tuber	Number of large-sized tuber	Soluble carbohydrate content %	Crude protein content %
Replication	2	5.52006E+06	2719.25	2.10718E+06	274.155	0.387	12.925
Treatment	14	3.19099E+06*	2063.53	308751	37.069	3.225	7.861
Residual	27	1.32621E+06	1296.74	234156	40.869	2.151	5.993
Total	44						

* F value significant at 5% level of probability.

Appendix 16: Mean squares from analysis of variance for variety Greta medium and small-sized tuber number and yield as affected by herbicide treatments at Samaru in 1985 wet season.

Source of Variation	DF	Medium-sized tuber		Small-sized tubers	
		Yield per hectare	Number per hectare	Yield per hectare	Number per hectare
Replication	2	263760	143.265	160670	114.218
Treatment	14	1.23628E+06*	2020.37**	153232*	1591.87
Residual	27	499833	352.552	60021.4	969.722
Total	44				

* F values significant at 5% level of probability.

** F values significant at 1% level of probability.

Appendix 17: Mean squares from analysis of variance for weed cover scores at 6 and 9 WAP and at harvest, and cumulative weed dry matter production as affected by herbicide treatments at Sameru in the 1985 wet season.

Source of Variation	DF	Weed Cover Score			Weed dry matter production at harvest
		6 WAP	9 WAP	Harvest	
Replication	2	0.164	0.254	0.197	1294.63
Treatment	14	11.52**	12.351**	14.094**	1[illegible]690**
Residual	28	0.552	0.637	0.592	3036.42
Total	44				

* F value significant at 5% level of probability

** F value significant at 1% level of probability

WAP = Weeks after planting.

Appendix 18: Mean squares from analysis of variance for Greta crop vigour score at 6 and 9 WAP, plant height at 6 WAP, leaf number and dry weight per plant at 6 WAP as affected by herbicide treatments at Sameru in 1985 wet season.

Source of Variation	DF	Crop Vigour Score		Plant height	Leaf number per plant	Leaf dry weight per plant
		6 WAP	9 WAP	6 WAP	6 WAP	6 WAP
Replication	2	5.849	3.339	58.82	262.754	1.438
Treatment	14	2.692	3.46	125.634	67.803	6.772*
Residual	28	2.028	2.023	61.882	58.184	2.69
Total	44					

WAP = Weeks after planting

* = F values significant at 5% level of probability.

WAP = Weeks after planting.

Appendix 19: Mean squares from analysis of variance for leaf area index, crop growth rate, and haulm dry matter production for potato variety Creta at 6 and 9 WAP as affected by herbicide treatments at Samaru in 1985 wet season.

Source of Variation	DF	Leaf area index		Crop growth rate		Haulm dry matter production
		6 WAP	9 WAP	6 WAP	9 WAP	6 WAP
Replication	2	2.864	0.07	0.855	12.964	254.19
Treatment	14	5.117*	1.90	0.977	7.678	116.91
Residual	27	1.867	1.40	0.569	6.213	79.20
Total	44					

* F value significant at 5% level of probability.

WAP = Weeks after planting.

Appendix 20: Mean squares from analysis of variance for crop stand count at 2 WAP and at harvest, tuber dry weight and number per plant at 6 and 9 WAP as affected by herbicide treatments at Samaru, in 1985 wet season.

Source of Variation	DF	Crop stand count % per net plot		Tuber dry weight per plant		Tuber number per plant	
		2 WAP	At harvest	6 WAP	9 WAP	6 WAP	9 WAP
Replication	2	129.625	28.288	21.469	104.01	0.466	11.288
Treatment	14	46.184	2.879	13.636*	136.502**	3.752*	15.117
Residual	28	30.145	5.503	3.779	44.146	0.847	12.479
Total	44						

* F value significant at 5% level of probability.

** F value significant at 1% level of probability.

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