EFFECTS OF PERIOD OF WEED INTERFERENCE AND CHEMICAL WEED CONTROL ON RAINFED AND IRRIGATED PEPPERS (*Capsicum* spp).

By

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

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DECLARATION

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

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CERTIFICATION

This thesis titled EFFECTS OF PERIOD OF WEED INTERFERENCE AND CHEMICAL WEED CONTROL ON RAINFED AND IRRIGATED PEPPERS (Capsicum spp.) by JOSEPH A. ADIGUN 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

TO

THE KING OF KINGS

THE LORD OF LORDS

THE ALPHA AND OMEGA

THE BEGINNING AND THE END.

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ABSTRACT

Field trials were conducted to dertermine the effects of period of weed interference and evaluate various herbicides for weed control in sweet pepper (Capsicum annuum L.) and chilli piepper (C. frutescens L.), respectively at Samaru during the wet season in 1982 and at Samaru and Kadawa during 1982/83 dry season.

In all the trials, weed infestation for 9 weeks after transplanting and later significantly depressed various crop growth parameters such as crop vigour score, number of leaves and branches per plant and yield and yield attributes, including fruit number and fresh weight, compared with the crop kept weed-free throughout its growth. Although weed association with the crop during the first 6 WAT depressed crop vigour score, this effect was not reflected in sweet pepper fruit yield when the weeds were subsequently removed. In order to obtain statistically comparable fruit yield to that of the weed-free control in the wet season at Samaru, it was necessary to keep the crop weed-free for 6 WAT and later. In the dry season, however, both at Samaru and Kadawa, only crops kept weed-free beyond 6 and 9 WAT, respectively resulted in comparable fruit yield to the weed-free control. The critical period of weed competition was observed to be between 6 and 9 WAT.

Herbicide treatments which consistently combined effective weed control with high chilli pepper fruit yields comparable with the hoe-weeded control, during the wet and dry seasons include mixtures of alachlor with linuron and chlorbromuron at 1.0 + 0.5 and 1.0 + 1.0 kg a.i./ha, respectively, mixtures of linuron with diphenamid and oxadiazon at 0.5 + 6.0 and 0.5 + 2.0, respectively and pendimethalin plus metobromuron at 2.0 + 1.0 kg a.i./ha. Although high pepper fruit yield was obtained with both rates of metolachlor plus metobromuron during the wet season, these treatments did not consistently result in effective weed control.

In this study unchecked weed growth throughout the crop life cycle caused between 60 and 92% loss in potential pepper fruit yield.

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Chapter 1.

INTRODUCTION

1.1. Origin, Classification and Botany

Peppers (Capsicum spp), which are indigenous to the tropical America, belong to the family Solanaceae. The viability of pepper seeds and the ease with which they can be transported enhanced their rapid spread to the other parts of the tropices and sub-tropics from the New World by the Spanish and Portuguese explorers. The plants of Capsicum spp. are small and bushy 30 to 100 cm tall with variable alternate dark green leaves which are simple, pointed, ovate and are carried in long petioles. The flowers may be borne singly or in clusters of two in the leaf axis. The long history of pepper cultivation has led to to the establishment of a large number of varieties which differ in habit, mode of growth, and especially in size, shape, colour and pungency of fruits (Purseglove, 1968). In Nigeria, Capsicum annuum and C. frutescens are the most commonly cutivated species. Capsicum annuu include those cultivated peppers variously called sweet, red, green or bell peppers, which produce sweet to pungent fruits with varying lengths from 1 to 30 cm and may be green orange or red in colour. Capsicum frutescens, otherwise called "bird pepper" is however characterized by small pungent fruits.

1.2. Production and Uses of Pepper in Nigeria

Pepper is one of the most important commercially grown vegetable crops in Nigeria, and is usually grown in mixture with other vegetable crops. In northern Nigeria for example, peasant farmers inter-crop pepper with maize, yam and other vegetable crops such as okra, spinach and onions (Olarewaju, 1977). According to Steel (1965) and Olarewaju (1981), Nigeria used to be an exporter of pepper, especially in the 1960s and early 1970s. The Nigerian pepper was favoured in the world market because of its pungency and high level of vitamin content, especially vitamins A and E. In Nigeria, the crop constitutes about 40% of the vegetables consumed by human beings (Denton and Swarup, 1981) and is used in the fresh form or as paste, puree and juice or ground with other vegetables in the preparation of stew and soup. The large non-pungent fruits of C. annuum have large fleshy pericarp and are used in salads or may be stuffed with meat and cooked.

An estimated 60,000 hectares of land were cultivated to pepper annually in Nigeria between 1969 and 1971 with an average annual production of 484,000 metric tonnes during the period. In 1980, total pepper production was 627,000 metric tonnes from 69,000 hectares of land thus giving an average yield of 9 t/ha (Anon. 1980).

1.3. Agronomic Practices

The pepper seedling is customarily raised in a nursery bed, seed box or seed bed and later transplanted onto the field. Pepper requires a warm climate with an average daily temperature of about 24°C and adequate humidity. It is sensitive to cold and most varieties are killed by frost. The crop does best on sandy loam soils with high nutrient and humus content. Seedlings are ready to be transplanted when seven and half to ten centimeters tall or at six to eight weeks after sowing. The plants are normally spaced 30 to 38 cm apart. Super-phosphate fertilizer is applied at the rate of 46.3 kg P_2O_5/ha during land preparation. Also, calcium ammonium nitrate (CAN) at the rate of 250 kg/ha is equally split applied at 3 weeks after transplanting and at first set of fruits. Pepper is normally harvested when matured or green (Grubben, 1977; Anon. 1982).

1.4. Weed Problems and Control in Pepper

Although peppers are widely cultivated throughout Nigeria, the estimated yield of 9 t/ha for the country does not compare well with the estimated yield of 15 t/ha obtained in Western Europe (Anon. 1980). The low yield of 9 t/ha of pepper in Nigeria has been attributed to a number of production constraints which mainly include the inability of peasant farmers to

combact the problem of diseases, pests and weeds. Weeds limit efficient pepper production by competing with the crop for light, moisture and nutrients. Some weed species are alternate hosts of pests and diseases which attack pepper. In Beit Dagan and Beit Hagedi in Israel, losses ranging from 36 to 56% in pepper fruit yields were reported by Eshel and Katan (1972) when weeds were allowed to compete with the crop for 30 days after transplanting, while a complete 100% loss in fruit yield was reported in seeded pepper when weeds competed with the crop from the time of sowing until harvest (Taylorson, 1965). At Samaru in Nigeria, Olaleye (1982) and Falalu (1983), respectively reported 90% and 100% losses in sweet pepper fruit yield due to unchecked weed growth throughout the crop life cycle.

In Nigeria, hoe-weeding is the most common weed control practice. Apart from being expensive, labour for weeding is unreliable in terms of availability, thus making precision difficult to attain (Olunuga and Akobundu, 1980). The mass exodus of the available farm labour to the urban areas and rising wages demand a less labour-intensive and more profitable weed control method to attract more producers, increase their area of production and subsequently the national output (Lagoke et al. 1981). Chemical weed control is considered to show more promise than hoe-weeding since

it will reduce labour requirement and its attendant costs, increase profitability and also facilitate efficient weed control in vegetable production (Sinha et al. 1983).

1.5. Objectives

The objectives of this tudy therefore are as follows:

1. To evaluate the effects of periods of weed interference on pepper and to determine the critical period of weed competition in the crop.
2. To evaluate the performance of various herbicides for weed control in pepper.

Chapter 2

REVIEW OF LITERATURE

2.1. Weed Competition

2.1.1. Losses due to weed competition in pepper

Pepper, like many other vegetable crops, is very sensitive to weed competition, especially during its early stage of growth (Olaleye, 1982; Lawal, 1982). At Beit Dagan and Beit Hagedi in Israel, losses ranging from 36 to 56% in pepper fruit yield have been reported by Eshel and Katan (1972) when weeds were allowed to compete with the crop for 30 days after transplanting, while a complete 100% loss in fruit yield was reported in seeded pepper when weeds competed with the crop from the time of sowing until harvest (Taylorson, 1965).

At Samaru in Nigeria, Olaleye (1982) observed that weed-infestation with sweet pepper (Capsicum annuum) for 6 weeks after transplanting (WAT) resulted in significant yield reduction and depression of various growth attributes such as plant height, crop vigour score, leaf count, flower production and number of fruits produced per plant and that unchecked weed growth throughout the crop life cycle resulted in 90% reduction in sweet pepper potential yield. In a similar study on chilli pepper, Lawal (1982) reported

that yield loss could not be obviated by subsequent weeding, once the crop was weed-infested until 9 weeks after transplanting. In the study, it was reported that keeping pepper plant weed-free for 6 WAT resulted in optimum yield while weed-infestation until 9 and 12 WAT, and until harvest resulted in yield reduction of 77%, 82% and 87%, respectively. Also, Nongu (1982) Uwannah (1982) Idris (1983) Yusuf (1983) and Falalu (1983), respectively reported 94, 95, 96, 98 and 100% losses in pepper fruit yield due to unchecked weed growth throughout the crop life cycle.

2.1.2. Critical period of weed competition in vegetable crops

The period of the crop growth when it is most susceptible to weed interference has been termed as the critical period of weed competition by Nieto et al. (1968). In some crops it was found that the final yields were unaffected by the presence of weeds up to a particular stage after crop emergence, if the weeds were subsequently removed and the crop was kept weed-free until harvest. Conversely, if kept free of weeds until some particular growth stage, weeds that emerge and develop subsequently would not affect the yield. In between these stages, there is a period during which the weeds must be eliminated. This period

has been termed the critical period of weed competition (Nieto et al, 1968). The precise time and duration of period of maximum competition depends on many factors such as relative rate of growth of the crop and weeds, weed flora, crop plant population, the variety of the crop grown and the time of moisture and nutrient stress.

Various workers have established critical period during which weed competition exerts an irreversible effect on the final crop yield. In a study on weed interference in transplanted tomatoes in Canada, Friesen (1977) observed that the critical period of weed competition in the crop was between 24 and 36 days after transplanting. In Maryland, in the United States of America, Beste (1979) reported that tomatoes needed to be kept weed-free for 6 WAT to avoid yield reduction. In the study, the researcher observed that yields of tomatoes were not significantly reduced if the weeds were removed for 3 WAT the crop.

In two field experiments conducted at Samaru, in Nigeria, Lawal (1982) and Olaleye (1982) respectively reported that the critical period of weed competition in transplanted chilli and sweet peppers was between 3 and 6 weeks after transplanting.

2.2. Chemical Weed Control in Pepper

The feasibility of chemical weed control in various vegetable crops have been reported by several workers (Taylorson, 1965; Cialone, et al, 1969; Dempsey and Frets, 1973; Orkwor, 1981; Sinha et al, 1982; Sinha and Lagoke, 1983). Herbicides that have been suggested for selective weed control in pepper in different parts of the world include diphenamid, alachlor, pendimethalin, dacthal, linuron, chlorbromuron, metobromuron, metolachlor and oxadiazon (Kasasian, 1963; Orsenigo and Ozaki, 1965; Perez, 1970; Sambhi and Randhawa, 1976; Americanos, 1976; Nongu, 1982; Uwannah, 1982; Falalu, 1983; Idris, 1983; Yusuf, 1983). These herbicides have either been applied singly to control some categories of weeds or in mixtures for the control of a broad spectrum of weeds (Uwannah, 1982; Idris, 1983).

2.2.1. Diphenamid

Diphenamid (N, N-dimethyl-2,2-diphenylacetamide) is an amide used pre-emergence for selective weed control in solanaceous crops. No evidence is available to date concerning the basis for the selectivity of diphenamid in pepper. However, it has been shown that tolerance of tomato to this herbicide is based specifically on degradation to non-phytotoxic

metabolites (Lemin, 1966; Gentner, 1969). Diphenamid uptake occurs through the roots and shoots of both tolerant and susceptible plants. This root-absorbed diphenamid moves rapidly into the leaves of the resistant plants, while in susceptible plants movement into the shoots is slow (Bingham and Shaver, 1971; Eshel and Katan, 1972).

Diphenamid applied pre-emergence at 2.3 to 9.0 kg a.i./ha has been used for selective control of grass seedlings and some broad-leaved weeds in pepper, in the West Indies (Kasasian, 1963). In Florida, USA, Orsenigo and Ozaki (1963) observed that diphenamid at 4.48 kg a.i./ha was one of the best treatments for weed control in pepper. It reduced the labour required for hand-weeding by more than 50% and increased pepper fruit yield by 10% compared with hand-weeded control. Orsenigo and Ozaki (1965) obtained acceptable to excellent control of grasses and broad-leaved weeds in pepper with pre-emergence application of diphenamid at 4.0, 6.0 and 8.0 kg a.i./ha.

Labrada and Paredes (1979) reported that pre-emergence application of diphenamid at 3.2 kg a.i./ha resulted in good selective weed control in pepper seedlings. In the experiment, it was observed that there were 67% and 91.4% reduction in the number of weeds and their dry weight, respectively, while the

number of vigorous pepper seedlings substantially increased. Labour cost was also reduced considerably.

Gluhaich (1980) obtained satisfactory weed control and increased pepper yield with pre-emergence application of diphenamid at 4.8 kg a.i./ha in San Luis, California. Moen et al. (1980) applied diphenamid at 5.0 kg a.i./ha in pepper nursery and obtained effective weed control while Pereira et al. (1980) reported satisfactory control of both grasses and broad-leaved weeds with pre-emergence application of diphenamid at 6.0 kg a.i./ha in pepper.

The effect of timing of pre-emergence application of diphenamid at 4.0 to 10.0 kg a.i./ha in pepper (Capsicum annuum) was studied in the green house and field trials in sandy loam and clay soils. Delaying application of diphenamid from the day of sowing until just before emergence reduced toxicity. The addition of mixture of diquat plus paraquat at 2.0 plus 0.4 kg a.i./ha resulted in effective control of weed seedlings which emerged after sowing and significantly increased pepper fruit yield (Eshel and Katan, 1972).

Pelletier (1967) applied diphenamid at 6.0 and linuron at 0.5 kg a.i./ha one day before transplanting pepper and observed that both were tolerated by the

crop and increased yields more than the hand-weeded control. In Nigeria, Nongu (1982) applied pre-transplant diphenamid plus linuron at 4.0 + 0.5 and 8.0 + 0.5 kg a.i./ha and observed significant reduction in weed weight as well as high pepper fruit yield compared with the untreated control. Diphenamid at 3.0 kg a.i./ha followed by supplementary hoe-weeding at 4 WAT resulted in high pepper fruit yield comparable with hoe-weeded control, but exhibited weak activity on weeds (Idris, 1983).

Americanos (1976) observed that diphenamid at 3.4 to 4.5 kg a.i./ha applied post-planting gave satisfactory weed control in pepper. In a post-emergence weed control trial in seeded pepper, Korosmezei (1979) observed that diphenamid at 6.0 kg a.i./ha was one of the most effective treatments, both in terms of selectivity and weed control.

2.2.2. Alachlor

Alachlor (2-chloro-2,6-diethyl-N-(methoxymethyl) acetamide) like diphenamid is an amide, mainly available as an emulsifiable concentrate formulation in this country. It is applied as a pre-emergence treatment for selective control of annual grasses and certain broad-leaved weeds in some field and horticultural crops. Acceptable tolerance of this

herbicide has been exhibited by beans, onions, transplanted tomatoes, eggplant and pepper (Sambhi and Randhawa, 1976; Medrano et al. 1980; Uwannah, 1982; Idris, 1983). It has been suggested that the activity of this herbicide is enhanced by blocking the normal carbohydrate metabolism as well as protein synthesis in the hypocotyl thus inhibiting stem elongation and hence seedling emergence. The seedlings which succeed in emerging are stunted and malformed. As in the case of diphenamid, the selectivity of alachlor is based on differential rate of movement in tolerant and susceptible plants. The root-absorbed alachlor moves rapidly into the leaves of the resistant plants, while in susceptible plants, movement into the shoots is slow (Bingham and Shaver, 1971).

In New York, Sweet et al. (1980) observed that alachlor at 1.2 kg a.i./ha gave effective weed control in pepper, while Ogle (1972) reported that pre-emergence application of alachlor at 2.24 and 4.48 kg a.i./ha gave good weed control and good selectivity in transplanted tomatoes and pepper. Sambhi and Randhawa (1976) applied alachlor plus EPTC at 2.5 + 3.8 kg a.i./ha one day before transplanting pepper and reported good control of weeds including Cyperus rotundns without any adverse effect on the crop. Americanos (1976) recommended the use of alachlor at 2.2 kg a.i./ha

applied before transplanting pepper. In Western Malaysia, Blencome and Blencome (1970) applied alachlor at 2.1 kg a.i./ha in sandy loam and 4.2 kg a.i./ha in neavier soils and observed selective control of seedling grasses and some broad-leaved weeds in chilli pepper. Bagley and Beste (1982) reported that the pre-plant application of alachlor at 1.5 kg a.i./ha reduced pepper vigour, but alachlor plus trifluralin at 1.0 + 0.5 kg a.i./ha gave the highest pepper yield. In Nigeria, Uwannah (1982) obtained acceptable weed control and high pepper fruit yield with pre-transplant application of alachlor plus linuron at 2.0 + 0.5 kg a.i./ha, while Idris (1983) reported that alachlor at 1.0 and 2.0 kg a.i./ha followed by supplementary hoe-weeding at 4 WAT gave selective weed control in chilli pepper.

2.2.3. Metolachlor

Metolachlor (2- chloro-N- (2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethy) acetamide) is a pre-emergence chloroacetamide herbicide used for selective weed control in field crops like cowpea, cotton, yam corn, soybean and some horticultural crops (Sinha and Lagoke, 1982; Uwannah, 1982; Nongu, 1982; Idris, 1983; Yusuf, 1983). Acetamide herbicides characteristically provide pre-emergence control of many annual grasses and certain broad-leaved weeds in agronomic and horticultural crops.

Talbert, et al. (1979) reported satisfactory weed control in bell pepper (Capsicum annuum var. Grossum) with pre-emergence application of metolachlor at 1.68 to 3.36 kg a.i./ha. In an evaluation of pre-transplanting herbicides for weed control in pepper at Samaru in Nigeria, Nongu (1982) applied metolachlor plus linuron at 1.0 + 0.5 kg a.i./ha and reported good weed control as well as high pepper fruit yield, while Uwannah (1982) who evaluated a different set of herbicide mixtures obtained high pepper yield with metolachlor plus metobromuron at 1.5 + 1.5 kg a.i./ha. Idris (1983) also observed that metolachlor at 2.0 kg a.i./ha, followed by supplementary hoe-weeding at 4 weeks after transplanting combined acceptable weed control with high pepper fruit yield comparable to the hoe-weeded control.

2.2.4. Oxadiazon

Oxadiazon (2-tert-butyl-4-(2,4-dichloro-5-isopropoxyphenyl)- Δ^2-1,3,4-oxadiazolin-5-one) is an heterocyclic compound used both as pre- and post-emergence herbicide. It is usually formulated as an emulsifiable concentrate. The basis for herbicidal activity of this chemical is related to inhibition of Hill reaction in photosynthesis in susceptible plants thus causing stunted growth or death of such plants.

Selectivity of this herbicide is based on its low solubility in water. After application it remains fixed to the soil colloids. Consequently, frequent water movement does not easily dissolve the product which will always remain on the soil surface to control the weeds (Audus, 1976). Oxadiazon has been used for selective weed control in several crops like rice, soybean, onion, eggplant and pepper (Orkwor, 1982; Sinha and Lagoke, 1982; Uwannah, 1982).

At Tel Aviv in Israel, the effect of oxadiazon at 0.75, 1.5, 3.0 and 6.0 kg a.i./ha applied as root and stem dip was studied on tomato, eggplant and pepper seedlings in the green-house. Tomato was the most susceptible and pepper the most resistant to oxadiazon (Sheinbaum, 1978). In an evaluation of some pre-ttransplant herbicides for weed control in chilli pepper (Capsicum frutescens) at Samaru in Nigeria, Uwannah (1982) obtained a good weed control as well as high peper fruit yield with application of oxadiazon plus linuron at 2.0 + 0.5 kg a.i./ha followed by supplementary hoe-weeding at 5 WAT.

2.2.5. Chlorthal-dimethyl ester

Chlorthal-dimethyl or DCPA (2,3,5,6-tetrachloro-terephthalic acid dimethyl ester) is a pure white crystalline, odourless compound and it is available in Nigeria as a wettable powder. Chlorthal-dimethyl

has been used widely as a pre-emergence herbicide for weed control in various crops like alfalfa, soybean, corn, tobacco, onions, tomatoes and peppers (Ambling and Turner, 1961; Lange, 1969; Orkwor, 1981, Nongu, 1982; Sinha and Lagoke,,1983). The herbicidal action of chlorthal-dimethyl is related to mitotic poisoning in susceptible plants. Mitotic cycles are interrupted and cell division ceasses in the root and shoot meristems of seedlings of susceptible plants. Such effects are generally accompanied by the precocious enlargement of cells in the meristem (Bingham, 1968). The selectivity of this herbicide is thought to be due to its conversion to non-phytotoxic metabolites in tolerant plants (Kearney and Kaufman, 1969).

A number of workers have reported successful use of chlorthal-dimethyl either singly or in mixture with other herbicides to control weeds in pepper. Chiapirinni (1972) recommended the pre-emergence use of chlorthal-dimethyl at 11.0 to 13.0 kg a.i./ha for weed control in pepper. Orsenigo and Ozaki (1963) found that application of chlorthal-dimethyl at 5.6 kg a.i./ha, 3 days after sowing retarded the emergence of pepper, but did not significantly affect the plant stands. Lange (1969) observed that pre-emergence application of chlorthal-dimethyl at 6.72 kg a.i./ha was tolerated by transplanted tomatoes and eggplant,

but injured direct-sown tomato and pepper. Pre-emergence application of chlorthal-dimethyl at 6.72 kg a.i./ha was, however, reported to give good weed control in transplanted peppers and tomatoes without any observable crop injury (Locascio, 1962). In a trial on a very fine sandy loam soil, Wascome (1967) obtained excellent weed control in chilli pepper with pre-emergence application of chlorthal-dimethyl at 8.96 kg a.i./ha. In an evaluation of various pre-transplant herbicide mixtures for weed control in pepper at Samaru, in Nigeria, Nongu (1982) reported that application of chlorthal-dimethyl plus linuron at 6.0 + 0.5 kg a.i./ha followed by supplementary hoe-weeding at 6 WAT, resulted in significant weed reduction and high pepper fruit yield compared with the untreated check. However, Idris (1983) obtained poor pepper fruit yield with chlorthal-dimethyl at 6.0 and 12.0 kg a.i./ha, even when followed by supplementary hoe-weeding at 4 WAT.

2.2.6. Pendimethalin

Pendimethalin (N-(1-ethylpropyl)-3,4-dimethyl-2-6-dinitrobenzen-amine) like other dinitroaniline herbicides, generally inhibit weed seed germination and associated physiological growth process by disorganizing mitotic divisions in root cells (Oliver and Frans, 1968). Pendimethalin has been widely used mainly as a pre-emergence herbicide for the control

of annual grasses and broad-leaved weeds in some crops such as beans, onions, tomatoes and pepper (Aston, 1978; Gluhaich, 1980; Uwannah, 1982; Bagley and Beste, 1982; Idris, 1983).

In Brazil, Pereira et al. (1977) reported that pendimethalin used at 0.75 and 1.75 kg a.i./ha gave satisfactory control of grasses and broad-leaved weeds with a significant high pepper fruit yield. In an evaluation of herbicides for weed control in bell pepper, Gluhaich (1980) found that pendimethalin at 1.2 kg a.i./ha alone or in combination with EPTC at 3.0 kg a.i./ha, incorporated prior to transplanting pepper, gave satisfactory weed control and increased pepper yield. Bagley and Beste (1982) reported successful control of Digitaria sanguinalis in pepper with pre-transplant application of pendimethalin at 0.75 to 1.5 kg a.i./ha. At Samaru, in Nigeria, Uwannah (1982) reported that pendimethalin plus linuron at 1.0 + 0.5 kg a.i./ha was one of the promising herbicide treatments which gave good weed control with high pepper fruit yield when supplemented with hoe-weeding 6 WAT. Idris (1983) also obtained acceptable weed control and high pepper fruit yield with the application of pendimethalin at 1.5 kg a.i./ha followed by supplementary hoe-weeding at 4 WAT.

2.2.7. Dimethametryn

Dimethametryn (2-(1,2,dimethylpropylamino)-4-ethylamino-6-methylthio-1,3,5-triazin) is a selective herbicide used for weed control in rice maize, soybeans, mungbeans and groundnuts (Anon. 1975). The selectivity of this herbicide is probably based on its ability to inhibit Hill reaction of photosynthesis in susceptible plants, thereby causing depressed growth and subsequent death (Audus, 1964). Dimethametryn was reported by Martins and Worthing (1974) to be effective against broad-leaved weeds in rice. In a site infested with Cyperus spp, Monochoria Vaginalis and Echonoclea spp, it was reported that dimethametryn mixture with piperophos at the rate of 0.5 + 0.5 kg a.i./ha applied 4 days after transplanting rice during the wet season, gave yield similar to hand weeding (Anon. 1976).

There is little published information on the effect of dimethametryn on vegetable crops. Mamtso (1983) obtained effective weed control and high okra pod yield with directed post-emergence application of dimethametryn plus metribuzin at 1.0 + 0.25 kg a.i./ha. Falalu (1983) however, reported poor weed control, depressed crop growth, reduced stands and consequent poor pepper fruit yield with application of dimethametryn at 0.25 kg a.i./ha followed by supplementary hoe-weeding at 7 WAT.

2.2.8. Linuron

Linuron (3-4-dichlorophenyl)-1-methylurea) a substituted urea, is mainly formulated as a wettable powder containing 50% active ingredient and is closely related to other substituted urea compound namely monolinuron, monuron and diuron. Linuron is a systemic herbicide which is absorbed mainly through the root system and the leaves. The herbicidal activity of linuron is based on its interference with photosynthesis by inhibiting the Hill reaction for which water is required for the synthesis of carbohydrates. The water molecule normally splits into $H^+ + OH^-$ during the process. Linuron inhibits this process thereby rendering the plant incapable of carbohydrate synthesis (Overbeek, 1964).

The selectivity of linuron is based on differential movement, distribution and detoxification rate in the plant. It has a low water solubility and hence its movement in the soil is almost negligible. In a pre-emergence application the active ingredient is therefore fixed in the uppermost layer of the soil where the majority of annual weeds germinate while the seeds of cultivated plants lie deeper in the soil. In addition to the above basis for selectivity, certain species of plants are tolerant because they are able to degrade the herbicide, while others appear to have an inherent

resistance to the herbicide. For example, linuron can be used selectively for annual weed control in carrots as a post-emergence treatment. The basis of these selectivities are usually restricted absorption and translocation or rapid inactivation by the crop plant (Ashton and Craft, 1973).

In France, pre-emergence application of linuron at 0.5 kg a.i./ha has been reported to have selectively controlled weeds in pepper (Pelletier and Coilier, 1969). Ignatov (1972) however, observed that linuron at 2.0 kg a.i./ha injured most of the Capsicum spp grown on calcareous chemozey soil. In order to avoid crop injury and at the same time obtain satisfactory weed control in pepper, the use of a mixture containing low rate of linuron and a well tolerated grassy weed herbicide has been suggested by Uwannah (1982). In a field trial at Samaru, the worker obtained high pepper fruit yield with pre-emergence application of linuron mixture with pendimethalin and alachlor each at 0.5 + 1.0 and 0.5 + 2.0 kg a.i./ha. Nongu (1982) also reported effective weed control, increased crop vigour and high pepper fruit yield with metolachlor plus linuron at 1.0 + 0.5 kg a.i./ha followed by supplementary hoe-weeding at 6 WAT. Successful weed control and high pepper fruit yield was obtained with linuron mixture with diphenamid and metolachlor at 0.5 + 4.0 and 0.5 + 2.0 kg a.i./ha, respectively (Yusuf, 1983).

2.2.9. Metobromuron

Metobromuron (2-(4-bromophenyl)-1-methoxy-1-methylurea) is a substituted urea used as a pre-emergence herbicide for weed control in onion, groundnuts, sunflower, beans, potatoes, tobacco, tomato and pepper (Romero and Espana, 1975; Sinha and Lagoke, 1982; Uwannah, 1982). The activity of this herbicide occurs through interference with photosynthesis by inhibiting Hill reaction thereby rendering the susceptible plant incapable of carbohydrate synthesis (Overbeek, 1964). The selectivity of metobromuron appear to be associated with presence or absence of a halogen atom in the phenyl ring (Anon. 1973).

Uwannah (1982) suggested the use of metobromuron in mixture with an appropriate grass weed killer in order to obtain wide spectrum of weed control. The worker used metobromuron mixture with metolachlor at 0.75 + 0.75 and 1.5 + 1.5 kg a.i./ha and obtained good weed control until 6 WAT and high pepper fruit yield. Similarly, Nongu (1982) observed that metobromuron plus metolachlor at 0.75 + 0.75 and 1.5 + 1.5 kg a.i./ha gave higher pepper fruit yield than the untreated check.

2.2.10. Chlorbromuron

Chlorbromuron (N-(4-bromo-3-chlorophenyl)-N-methoxy-N-methylurea) is also a substituted urea and it is used as a soil-applied herbicide. The use of the herbicide for weed control in vegetable crops has been reported by a number of workers (Deuber et al., 1970).

In two field trials carried out on loamy sandy soils both heavily infested with broad-leaved weeds Deuber et al. (1977) reported satisfactory weed control in onion with chlorbromuron at 1.25 kg a.i./ha. In this trial no adverse effects were observed on stand or bulb production. In Mexico, Perez (1970) applied chlorbromuron at 2,3,4,8 and 12 kg a.i./ha to chilles and observed that 90% of broad-leaved weeds were controlled for 90 days after application. Control of grasses and sedges was obtained for 60 days. The most successful treatments were those made early post-emergence of weeds either before or after irrigation. Late post-emergence application when weeds were 20 cm high was less successful. Among the rates tested, 4 kg a.i./ha gave as good weed control as high rates of 8.0 and 12.0 kg a.i./ha and no crop injury was observed provided spray did not touch the leaves of the crop.

Chapter 3

MATERIALS AND METHODS

3.1. Experimental Sites

Two field experiments were conducted during the wet season in June 1982 at the Institute for Agricultural Research Farm, Samaru (11° 11'N 07° 38'E) in the northern Guinea savanna ecological zone of Nigeria. The trials were repeated in November during the 1982/83 dry season at the Irrigation Research Station of the Institute for Agricultural Research Station, Kadawa in the Sudan savanna ecological zone of Nigeria. The trial on weed competition was also conducted on the Ahmadu Bello University Farm during the 1982/83 dry season. The dry season trials were conducted under furrow irrigation.

The soils at the experimental sites were deep freely-drained sandy loam with low organic matter content. Details of the physico-chemical characteristics of the soils are shown in table 1. The total rainfall recorded during the 1982 wet season was 769 mm and only 523 mm occurred during the crop life cycle. The common weed species at the experimental sites are indicated in table 2.

3.2. Nursery management

Seed-beds of 1.0 m wide by 6.0 m long were prepared and single superphosphate fertilizer was

Table 1. Physico-chemical analysis of soil samples from the experimental sites, at Samaru and Kadawa.

	Wet Season 1982	Dry Season 1982/83	
	IAR Farm Samaru	University Farm Samaru	Kadawa
Fine sand (%)	30.56	58.53	55.27
Coarse sand (%)	20.60	0.95	4.73
Fine silt (%)	8.67	3.00	2.30
Coarse silt (%)	21.60	18.00	28.00
Clay (%)	18.25	18.67	9.33
Organic carbon (%)	0.32	0.85	0.37
PH 1:1 (H_2O)	5.26	6.95	5.80
PH 1:25 (0.01 M$Cacl_2$)	5.48	6.63	5.77
CEC (Meq/100g soil)	15.60	2.90	4.60

Table 2. List of weed species present at the experimental sites.

Weed Species	Occurrence		
	Wet season 1982	Dry season 1982/83	
	IAR Farm Samaru	University Farm Samaru	Kadawa
2 (a) Annual grasses			
Eleusine indica (L.)	+++	+++	+++
Eragrostis tremula (L.)	++	+	+
Chloris pilosa Schum.	++	+	+
Digitaria ciliaris (Ret_2) Kock	+++	+	+++
Dactyloctenium aegyptium (L.) Richt.	+++	+	++
Cynodon dactylon (L.) Pers	+++	++	++
Imperata cylindrica (L.) Beauv	-	++	-
2 (b) Broad-leaved weeds			
Vernonia ambigua (L.)	+++	+	+++
Vernonia pauciflora (L.)	+++	+	+++
Amaranthus spinosus (L.)	+++	++	++
Solanium nigrum (L.)	++	+	+++
Solanum nodiflora (L.)	++	+	+++
Hyptis odoratum (L.)	+	-	+++

Weed Species	Wet season 1982	Dry season 1982/83	
	Samaru	Samaru	Kadawa
Portulaca oleraceae (L.)	++	+	++
Acanthospermum hispidium DC.	+	++	+
Ipomea aquatica (Forst)	+++	++	+
Cassia tora (L.)	++	++	+
Agerantum conyzoides (L.)	++	+	+
2 (c) Sedges			
Cyperus rotundus (L.)	++	+++	++
Cyperus esculentus (L.)	++	+++	++

+++ High occurrence

++ Moderate "

+ Minor "

- Nil

incorporated at the rate of 46.3 kg P_2O_5/ha before seeding. Seeds of sweet pepper (Capsicum annuum var. California mild) and chilli pepper (Capsicum frutescens var. Serrano chilli) were used since the quantity of available seeds of each species was inadequate for both trials. The seeds were obtained from the Horticultural Unit of Institute for Agricultural Research, Samaru. The seeds were sown in drills of 15 cm apart and covered lightly with soil and mulched with dry grass. Water was applied regularly as required using watering can to keep the soil moist. Seedlings which emerged five days after sowing were transplanted at 6 weeks after sowing.

3.3. Land preparation transplanting and cultural practices

In all the trials, the land was ploughed and disc-harrowed at two weeks later. Single super-phosphate was uniformly broadcast at the rate of 46.3 kg P_2O_5/ha before ridging at 75 cm apart. Six-week old pepper seedlings were transplanted (one plant per stand) at an intra-row spacing of 50 cm. Calcium ammonium nitrate at 65 kg N/ha was equally split-applied as side-dressing at 3 weeks after transplanting and at first set of fruits. Cymbush 1.8 ULV, was applied at the rate of 2 l/ha to control insect pests which infested the crop at Samaru during the wet season. All weedings were done with hand-hoe.

In the case of chemical weed control trials, supplementary hoe-weeding was done at 9 and 10 weeks after transplanting during the wet and dry seasons, respectively. The experiments conducted during the dry season was irrigated twice per week, from the time of transplanting until the first set of fruits were produced, after which the crop was irrigated weekly until final harvest.

3.4. Herbicide application

Herbicides were applied with a knapsack sprayer using a deflecter nozzle at a swath width of 75 cm, a pressure of about 2.1 kg/cm^2 and in a spray volume of 250 l/ha. All herbicides were applied at one day before transplanting pepper seedlings. In the dry season trial, herbicides were applied after light irrigation, but at one day before transplanting pepper seedlings.

3.5. Treatments and Experimental layout

In all the trials, gross and net plot sizes were 3.75 m x 4.5m and 2.25 x 4.5 m, respectively. The weed competition experiment consisted of ten treatments laid out in a randomized complete block design and replicated four times. In one set of the treatments, plots were kept weed-free for 3,6,9 and

12 weeks after transplanting 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-infestation and weed-free throughout the crop growth were also included as controls. Weeding was done with the West African hand-hoe.

In the study on chemical weed control, sixteen herbicide mixtures were tried, each at two rates and compared with hoe-weeded and unweeded controls during the wet season of 1982. Twenty-one promising herbicide treatments selected from those evaluated in the wet season were further tested in the dry season and compared with hoe-weeded and unweeded controls. The treatments were also laid out in a randomized complete block design and replicated four times.

3.6. Data collection

The following observations were taken:

3.6.1. Weed Score and weed weight

Weed cover score was taken at 3,6 and 9 weeks after transplanting using the scale 0 to 10 where 0 was assigned to plots without any weed and 10 assigned

to plots with full weed cover. Samples of fresh weeds were taken from two quadrants each measuring 0.75 m^2 in each plot before any weeding was done and the total fresh weed weight produced recorded. The air-dried weed weight could not be recorded because they rotted before they were fully dried.

3.6.2. Crop growth parameters

A scale of 0 to 10 was used for the crop vigour score, where plots with fully healthy crop were assigned 10 and those with complete crop kill were assigned 0. Crop vigour scores were taken at the time indicated in the table.

Crop stand count was taken at harvest from the net plot in order to assess the effect of treatment on crop establishment. Plant height, number of leaves, branches and flowers of three tagged plants were also taken as specified in the tables.

3.6.3. Fruit weight and fruit number at harvest

Picking of pepper fruit started at about 10 to 12 weeks after transplanting. There were 10 and 4 pickings in the wet and dry season, respectively. Both the fresh weight and number of fruits at each harvest were taken and the total fruit weight of all the harvests

and fruit number per plant were recorded at the end of the final harvest.

3.7. Analysis of data

All data were subjected to statistical analysis. Regression analysis was also done on some variables. Least significant difference (LSD) values at 5% level of probability were used to compare treatment means where F values were significant.

Chapter 4

RESULTS

4. Effect of period of weed interference on sweet pepper

The effect of time of weed removal on the various growth parameters, yield and yield attributes of pepper viz crop vigour score, number of leaves and branches per plant, plant height, number of flowers and fruits per plant as well as fruit yield are presented in tables 3 to 13.

4.1.1. Crop vigour score

At Samaru during the wet and dry seasons, crop vigour score at 6 WAT was significantly depressed by weed infestation for 6 WAT, compared with the crop kept weed-free until 6 WAT (Table 3). In contrast, crop vigour score of plots kept weed-free for 3 WAT and those weed-infested for only 3 WAT were similar to that of the crop kept weed-free for 6 WAT in both trials. However, at 9 WAT at Samaru during the wet season, vigour score of crop weed-infested for 9 WAT was significantly depressed, while those kept weed-free for various periods and those weed-infested for only 6 WAT and earlier resulted in similar vigour score to that of the crop kept

weed-free until 9 WAT. At this site during the dry season, plots kept weed-free for 9 WAT and earlier and those kept weed-infested until 9 WAT and earlier were similar in vigour score at 9 WAT. Similarly, at Kadawa in the dry season, plots kept weed free for 6 WAT and earlier and those kept weed-infested for only 6 WAT and earlier were similar in vigour score at 6 WAT. However, at 9 WAT, vigour score of crops kept weed-infested for 9 WAT and those kept weed-free for only 3 WAT were significantly depressed compared with those kept weed-free for 9 WAT. Vigour score of crops kept weed-free for 6 and 9 WAT and those weed-infested for only 6 WAT and earlier were however similar.

In all the trials, crop vigour score was positively correlated with fruit yield and fruit number per plant and negatively correlated with weed weight. (Tables 11, 12 and 13). At Samaru during the wet season, crop vigour score was positively correlated with flower number, plant height, number of leaves and branches per plant ($r = 0.573$, 0.765, 0.792 and 0.818, respectively). Crop vigour score was also strongly and positively correlated with number of branches per plant ($r = 0.657$) at Kadawa during the dry season (Tables 11, 12 and 13).

Table 3. Effect of period of weed-interference on crop vigour score of sweet pepper.

Treatment	Pepper crop vigour score[1]					
	Wet season		Dry season			
	Samaru		Samaru		Kadawa	
	6 WAT	9 WAT	6 WAT	9 WAT	6 WAT	9 WAT
Weed-free for 3 WAT[2]	7.4	6.6	6.5	4.9	7.5	4.6
Weed-free for 6 WAT	7.3	7.4	7.0	4.8	8.4	6.8
Weed-free for 9 WAT	*	6.6	*	4.9	*	7.5
Weed-free for 12 WAT	*	*	*	*	*	*
Weed-free until harvest	*	*	*	*	*	*
Weed-infested for 3 WAT	6.5	8.1	6.0	6.5	8.8	8.5
Weed-infested for 6 WAT	6.0	5.9	4.5	5.0	7.9	5.8
Weed-infested for 9 WAT	*	4.1	*	5.8	*	4.8
Weed-infested 12 WAT	*	*	*	*	*	*
Weed-infested until harvest	*	*	*	*	*	*
SE ±	0.47	0.57	0.64	0.47	0.45	0.63
LSD at P = 0.05	1.33	1.64	1.87	1.39	1.26	1.78

1 Scoring scale 0-10, where 0 = crop completely dead, and 10 = fully healty crop.

2 WAT = Weeks after transplanting in this table and in subsequent tables

* = Treatments that have not been completely applied in this table and in subsequent tables.

4.1.2. Leaf number

At Samaru, during the wet season, leaf count at 6 WAT was significantly depressed by weed-infestation until 6 WAT, while plots kept weed-free for 6 WAT and earlier and those weed-infested for only 3 WAT had similar leaf number. Leaf count at 9 WAT was significantly depressed by weed-infestation until 6 and 9 WAT compared with the crop kept weed-free until 9 WAT, while plots kept weed free for various periods and those weed-infested for only 3 WAT and similar leaf count. At 12 WAT, however, only the plots initially weed-infested for 6 WAT and less produced comparable number of leaves of those of the plots initially kept weed free until 12 WAT. At Samaru during the dry season leaf count at 9 WAT were similar in all the plots except those of the plots initially kept weed-free for 3 WAT (Table 4).
At Kadawa during the dry season, leaf count at 15 WAT was significantly depressed by initial weed infestation until 6 WAT and later as well as initial weed removal for only 6 WAT and less compared with the crop kept weed-free throughout its growth. However, initial weed removal until 9 WAT and later, as well as weed infestation for only 3 WAT resulted in similar leaf count to that of the crop kept weed free throughout its growth.

Table 4. Effect of period of weed-interference on leaf number of sweet pepper.

Treatment	Leaf number per plant				
	Wet season			Dry season	
	Samaru			Samaru	Kadawa
	6 WAT	9 WAT	12 WAT	9 WAT	15 WAT
Weed-free for 3 WAT	54	68	57	104	107
Weed-free for 6 WAT	51	72	67	83	71
Weed-free for 9 WAT	*	90	104	83	140
Weed-free for 12 WAT	*	*	191	*	114
Weed-free until harvest	*	*	*	*	193
Weed-infested for 3 WAT	40	75	173	49	128
Weed-infested for 6 WAT	27	49	162	57	112
Weed-infested for 9 WAT	*	30	92	69	118
Weed-infested for 12 WAT	*	*	75	*	90
Weed-infested until harvest	*	*	*	*	50
SE ±	7.1	12.4	27.5	13.6	27.6
LSD at P = 0.05	20.6	35.0	77.8	39.4	77.9

As shown in Table 11, at Samaru in the wet season, leaf number was positively correlated with crop vigour score, plant height, number of branches, flower and fruit number per plant as well as fruit yield and negatively correlated with weed weight (r = 0.792, 0.680, 0.863, 0.840, 0.409, 0.551 and 0.514, respectively). In the dry season however, leaf number was not strongly correlated with any of the crop and weed parameters at Samaru, while it was only corrleated with flower number at Kadawa (r = 0.420).

4.1.3. Number of branches.

During the wet season at Samaru, weed association with pepper until 9 WAT caused significant reduction in number of branches per plant compared with the crop initially kept weed-free for 9 WAT, while crops initially kept weed-free for various periods and those initially weed-infested for only 3 and 6 WAT had similar number of branches (Table 5). At this site during the dry season, number of branches per plant at 9 WAT was not significantly affected by period of weed interference. At Kadawa in the dry season, number of branches per plant at 12 WAT was significantly reduced on plots kept weed free for only 6 WAT and less and those initially weed-infested for 9 WAT and more, compared with the crop kept weed free for 12 WAT.

Table 5. Effect of period **of weed**-interference on number of branches per plant of sweet pepper

Treatment	Number of branches per plant		
	Wet season	Dry season	
	Samaru 9 WAT	Samaru 9 WAT	Kadawa 12 WAT
Weed-free for 3 WAT	8	16	24
Weed-free for 6 WAT	10	17	32
Weed-free for 9 WAT	8	15	41
Weed-free for 12 WAT	*	*	51
Weed-free until harvest	*	*	*
Weed-infested for 3 WAT	9	16	42
Weed-infested for 6 WAT	7	17	38
Weed-infested for 9 WAT	4	14	34
Weed-infested for 12 WAT	*	*	20
Weed-infested until harvest	*	*	*
SE ±	1.4	1.3	6.12
LSD at P = 0.05	4.0	NS	17.3

Number of branches per plant was positively correlated with fruit yield, number of ruits and flowers per plant, crop vigour score, leaf number per plant and plant height and negatively correlated with weed weight at Samaru during the wet season (r = 0.699, 0.568, 0.744, 0.818, 0.863, 0.823 and 0.561, respectively). During the dry season, no strong relationship was observed between the number of branches and other parameters at Samaru but number of branches per plant was positively correlated with fruit yield, crop vigour score and negatively correlated with weed weight at Kadawa (r = 0.769, 0.657 and - 0.801, respectively).

4.1.4. Plant height

At Samaru during the wet season, plant height at 9 WAT was significantly reduced by weed infestation until 9 WAT, while plots kept weed free for various periods and those weed-infested for only 6 WAT and less had similar plant height. At this site in the dry season, plant height at 12 WAT were similar in plots initially kept weed-free and those initially weed-infested for various periods. However, no significant difference was observed among the various treatments at Kadawa (Table 6).

Table 6. Effect of period of weed interference on plant height of sweet pepper

Treatment	Plant height (cm)		
	Wet season		Dry season
	Samaru 9 WAT	Samaru 12 WAT	Kadawa 6 WAT
Weed-free for 3 WAT	36.0	86.8	23.5
Weed-free for 6 WAT	37.0	76.0	23.7
Weed-free for 9 WAT	32.0	77.5	*
Weed-free for 12 WAT	*	75.3	*
Weed-free until harvest	*	*	*
Weed-infested for 3 WAT	35.0	58.25	28.9
Weed-infested for 6 WAT	35.0	74.5	21.8
Weed-infested for 9 WAT	26.0	86.5	*
Weed-infested for 12 WAT	*	74.0	*
Weed-infested until harvest	*	*	*
SE ±	2.62	9.71	1.75
LSD at P = 0.05	7.59	28.17	NS

During the wet season, plant height was positively and highly correlated with fruit yield, fruit number, flower number, crop vigour score, number of leaves and branches per plant and negatively correlated with weed weight ($r = 0.610$, 0.461, 0.552, 0.765, 0.680, 0.823 and -0.461, respectively). In the dry season, there was no strong correlation between plant height and other crop parameters at Samaru, and it was only correlated with flower number at Kadawa ($r = 0.472$).

4.1.5. Flower number

At Samaru during the wet season, number of flowers per plant at 6 WAT was significantly reduced in plots initially weed-infested for 6 WAT as well as those kept weed-free for only 3 WAT, while flower number of crops kept weed-free for 6 WAT and those kept weed-infested for only 3 WAT were similar. At Samaru in the dry season, only crops initially weed-infested for 9 WAT produced s significantly lower number of flowers per plant than the crop kept weed-free until 9 WAT, while those kept weed-free for various periods and those initially weed-infested for only 6 WAT and less had similar number of flowers per plant. Time of weed removal had no significant effect on the number of flowers per plant at Kadawa during the dry season (Table 7).

Table 7. Effect of period of weed interference on flower number of sweet pepper

Treatment	Number of flowers produced per plant		
	Wet season	Dry season	
	Samaru	Samaru	Kadawa
	6 WAT	9 WAT	6 WAT
Weed-free for 3 WAT	5.2	13	5
Weed-free for 6 WAT	6.1	10	3
Weed-free for 9 WAT	*	16	*
Weed-free for 12 WAT	*	*	*
Weed-free until harvest	*	*	*
Weed-infested for 3 WAT	6.4	10	11
Weed-infested for 6 WAT	5.5	11	14
Weed-infested for 9 WAT	*	8	*
Weed-infested for 12 WAT	*	*	*
Weed-infested until harvest	*	*	*
SE ±	0.2	2.28	3.44
LSD at P =.0.05	0.62	6.61	NS

Flower number was positively correlated with crop vigour score, leaf number, plant height, number of branches per plant and negatively correlated with weed weight at Samaru during the wet season (r = 0.573, 0.840, 0.552, 0.744 and - 0.458, respectively). During the dry season at Samaru, flower number was not strongly correlated with any of the crop or weed parameters, but at Kadawa it was correlated with plant height and leaf number (r = 0.472, 0.420, respectively).

4.1.6. Fruit number

At Samaru during the wet season, plots initially kept weed-free for only 3 WAT and those weed-infested for 9 WAT and more, had significantly lower fruit number per plant compared with those kept weed-free throughout. However, plots kept weed-free for 6 WAT and more and those initially weed-infested for 6 WAT and less resulted in comparable fruit number per plant to those of the plots kept weed-free throughout the crop growth. If kept weed-free initially, the highest increase of three fruits per week was obtained when the crop was kept weed-free for further 3 weeks beyond the initial 3 WAT. Similarly, the highest reduction of five fruits per week occurred when initial weed-infestation was extended for further 3 weeks

Table 8. Effect of period of weed interference on fruit number of sweet pepper

Treatment	Pepper fruit number per plant at harvest		
	Wet season	Dry season	
	Samaru	Samaru	Kadawa
Weed-free for 3 WAT	6	10	11
Weed-free for 6 WAT	15	9	15
Weed-free for 9 WAT	16	11	24
Weed-free for 12 WAT	22	12	22
Weed-free until harvest	23	19	18
Weed-infested for 3 WAT	24	15	29
Weed-infested for 6 WAT	25	14	23
Weed-infested for 9 WAT	10	13	9
Weed-infested for 12 WAT	10	8	8
Weed-infested until harvest	3	8	6
SE ±	3.8	1.5	4.1
LSD at P = 0.05	10.6	4.2	11.5

beyond the first 6 WAT. At this site in the dry season, crops initially kept weed-infested for 6 WAT and more and those kept weed-free for 12 WAT and less had lower fruit number than that of the weed-free control. The highest increase of two fruits per plant per week was obtained by keeping the crop weed-free for 3 weeks beyond the initial 12 WAT. However, the highest reduction of two fruits per plant per week occurred when the crop was kept weed-infested for 3 weeks beyond the first 6 WAT. Fruit number per plant obtained from plots weed-infested for 12 WAT was not significantly different from those of the unweeded plots at Samaru in the dry season. At Kadawa, on the other hand, all the treatments except the unweeded check resulted in fruit number similar to the weed-free control. In this trial, the highest gain of 3 fruit per plant was obtained by keeping the crop weed-free for a further 3 weeks beyond the initial 6 WAT, while the highest reduction of three fruits per plant was obtained from plots initially kept weed-infested for 3 weeks beyond the first 6 WAT.

Fruit number was positively and strongly correlated with fruit yield, crop vigour score, plant height, number of leaves and branches per plant at Samaru in the wet season ($r = 0.814$, 0.411, 0.461, 0.409 and 0.568, respectively). In the dry season, fruit number was positively correlated with fruit yield, crop vigour

score and negatively correlated with weed weight at Samaru (r = 0.558, 0.779 and - 0.625, respectively), while it was correlated with fruit yield, crop vigour score and negatively correlated with weed weight at Kadawa (r = 0.707, 0.710 and - 0.553, respectively).

4.1.7. Pepper fruit yield.

In all the trials, weed association with pepper for 9 WAT and more caused significant reduction in pepper fruit yield, compared with the crop kept weed-free throughout its growth. At Samaru, during the wet season, plots initially kept weed-free for various periods beyond 3 WAT and those weed-infested for 6 WAT and less had similar fruit yields to those kept weed-free throughout the crop growth. In the dry season, however, only the plots kept weed-free until 9 WAT and more at Samaru and 12 WAT and more at Kadawa resulted in similar yield to that of the weed-free control (Table 9).

In these trials, unchecked weed growth resulted in about 80% loss in potential pepper fruit yield at Samaru in the wet season, 60% and 83% losses in sweet pepper fruit yields at Samaru and Kadawa, respectively, during the dry season. In all the trials, the highest yield loss per unit time occurred by keeping the plots

Table 9. Effect of period of weed interference on sweet pepper fruit yield

Treatment	Sweet pepper fruit yield (t/ha)		
	Wet season	Dry season	
	Samaru	Samaru	Kadawa
Weed-free for 3 WAT	4.54	2.73	2.25
Weed-free for 6 WAT	7.58	2.61	3.62
Weed-free for 9 WAT	7.19	3.39	4.81
Weed-free for 12 WAT	15.92	3.56	5.91
Weed-free until harvest	12.27	4.49	6.41
Weed-infested for 3 WAT	13.81	3.79	6.38
Weed-infested for 6 WAT	9.41	4.07	5.88
Weed-infested for 9 WAT	3.34	2.55	2.32
Weed-infested for 12 WAT	2.79	2.36	1.44
Weed-infested until harvest	3.00	1.82	1.10
SE ±	1.90	0.48	0.52
LSD at P = 0.05	5.36	1.37	1.47

initially weed-infested for fruther three weeks beyone the initial 6 WAT. These values which were based on actual fruit yields were 2.02 t/week for Samaru in the wet season, 0.84 and 1.19 t/week for Samaru and Kadawa, respectively in the dry season. On the other hand, the highest gain of 2.91 t/week in pepper fruit yield was obtained when the crop was initially weed-free for further 3 weeks beyond the first 9 WAT at Samaru during the wet season. At this site in the dry season, the highest gain of 0.31 t/week in fruit yield was obtained by keeping the plots weed-free for 3 weeks beyond the first 12 WAT. At Kadawa, weed removal beyond the first 3 weeks until 6 WAT resulted in greatest increase of 0.64 t/week in pepper fruit yield.

Figures 1 to 3 contain curves of predicted values of pepper fruit yield as related to weeding period using an equation:

$$Y = a + b_2 Z_2 + b_3 Z_3$$

where Z_2, Z_3, are functions of time of weeding period, chosen so that the sope is zero at t = 0 (time of transplanting) and t = 15 weeks (time of harvest) and a, b_2, b_3 are regression coefficients. This is a special case of the quartic equation:

$$Y = a + bt + b_2 t^2 + b_3 t^3 + b_4 t^4.$$

This equation gives a sigmoid relationship of yield and weeding time which is asymptotic both at t = 0 and t = 15 weeks. In the wet season at Samaru, it was obvious

that for 0%, 10% and 20% losses in potential sweet pepper fruit yield, weed-free requirement was from 2 WAT until harvest, 3 WAT to harvest and 4 to 12 WAT, respectively (Fig. 1). In the dry season, at the same site, plots ought to be kept weed-free from time of transplanting of pepper until harvest, 4 to 12 WAT and 7 to 10 WAT, respectively for yield reductions indicated above. At Kadawa in the dry season, it was required to keep plots weed-free from time of transplanting pepper until harvest, 4 to 11 WAT and 7 to 8 WAT for 0%, 10% and 20% losses in pepper fruit yield, respectively.

Pepper fruit yield was positively correlated with fruit number, number of leaves and branches per plant, crop vigour score, plant height and negatively correlated with weed weight at Samaru during the wet season ($r = 0.84$, 0.551, 0.699, 0.615, 0.610 and -0.514, respectively). In the dry season at Samaru, fruit yield was positively correlated with fruit number and crop vigour score ($r = 0.558$ and 0.622, respectively) while it was positively correlated with fruit number, crop vigour score, number of branches per plant and negatively correlated with weed weight at Kadawa ($r = 0.707$, 0.737, 0.769 and -0.734, respectively).

4.1.8. Total weed weight

The total weed weight presented in table 10 includes weights of weeds removed during weeding operations and

the weed-infestation at the time of final picking. In the wet season trial at Samaru, pepper plots weed-infested for 6 WAT and longer and those subsequently infested after initial removal for the first 3 WAT had high weed weights which were comparable to those of the plots unweeded throughout the crop growth. However, the plots that were infested with weeds for 3 WAT only, and those subsequently infested with weeds after their initial removal for 6 WAT and more, produced lower weed weights than those of the unweeded control. In the dry season at this site, weed-infestation for 12 WAT and weed removal until 9 WAT and less resulted in comparable weed weight to that of the unweeded control. However, weed weights of the plots kept weed-free for 12 WAT and throughout the crop growth and those weed-infested until 9 WAT and less were significantly lower than those of the plots weed-infested throughout at Samaru in the dry season. At Kadawa on the other hand, weed association with pepper until 12 WAT resulted in high weed weight comparable to that of the crop unweeded throughout its growth, while initial weed removal for various periods as well as weed infestation for 9 WAT and less resulted in lower weed weight (Table 10). The highest weekly reduction of 10.29 t/ha of weed weight occured at Samaru during the wet season when weeds were removed from pepper for a further 3 weeks beyond the initial

Table 10. Fresh weed weight as affected by period of weed interference in sweet pepper

Treatment	Weed weight at harvest (t/ha) Wet season 1982 Samaru	Dry season 1982/83 Samaru	Dry season 1982/83 Kadawa
Weed-free for 3 WAT	39.41	11.19	20.40
Weed-free for 6 WAT	32.88	6.34	20.98
Weed-free for 9 WAT	1.94	6.59	8.35
Weed-free for 12 WAT	2.44	1.76	2.64
Weed-free until harvest	2.76	2.98	1.28
Weed-infested for 3 WAT	3.78	2.82	2.89
Weed-infested for 6 WAT	58.59	2.12	12.13
Weed-infested for 9 WAT	58.08	3.26	19.31
Weed-infested for 12 WAT	57.71	5.26	25.67
Weed-infested until harvest	62.99	9.88	34.39
SE ±	8.83	1.90	3.27
LSD at P = 0.05	24.99	5.38	9.25

6 WAT, while the highest weekly increase of 18.27 t/ha was obtained when the weeds infested the crop for a further 3 weeks beyond the first 3 WAT. At this site in the dry season, weed removal beyond the first 3 weeks until 6 WAT resulted in weed weight reduction of 1.61 t/ha per week, while weed infestation beyond 12 WAT until harvest resulted in weekly increase of 1.54 t/ha. At Kadawa, weed removal for further 3 weeks beyond the first 6 WAT caused 4.20 t/ha reduction in weed weight per week, while weed infestation for further 3 weeks beyond the first 3 WAT resulted in weekly increase of 2.8 t/ha in weed weight. As shown in figure 4, the period between 3 and 6 WAT appears to be the period of the most rapid weed growth in plots initially weed-infested at Samaru during the wet season. Apparently fresh weed weight did not increase from this time until harvest in those plots. On the other hand, the most rapid weed reduction occurred between the time of transplanting and 9 WAT in plots initially kept weed-free. Thereafter there was no reduction in fresh weed weight despite further weedings. At Samaru and Kadawa in the dry season (Figures 5 and 6) weed weight increased linearly from transplanting until harvest, while the most rapid weed reduction was observed in plots initially kept weed-free from transplanting until 12 WAT. Further weeding after this period did not seem to help in reducing fresh weed weight.

Weed weight was negatively correlated with fruit yield, fruit and flower numbers per plant, crop vigour score, plant height, number of leaves and branches per plant at Samaru during the wet season ($r = -0.514$, -0.384, -0.458, -0.466, -0.461, -0.514 and -0.561, respectively). In the dry season at this site, weed weight was negatively correlated with fruit number and crop vigour score ($r = -0.625$ and -0.558, respectively). At Kadawa, weed weight was negatively correlated with fruit number and yield, crop vigour score and number of branches per plant ($r = -0.553$, -0.734, -0.734 and -0.701, respectively).

Table 11. Correlation between weed weight, crop growth and yield and yield attributes as affected by period of weed interference at Samaru during the wet season in 1982

	Fruit		Flower	Crop growth				Weed
	Yield	Number	Number	Crop vigour	Plant height	Leaf number	Branches/plant	weight
Fruit yield	1.00	0.814	0.386	0.615	0.510	0.551	0.699	- 0.514
Fruit number		1.000	0.333	0.411	0.461	0.409	0.568	- 0.384
Flower number			1.000	0.573	0.552	0.840	0.744	- 0.458
Crop vigour				1.000	0.765	0.792	0.818	- 0.466
Plant height					1.00	0.680	0.823	- 0.461
Leave number						1.00	0.863	- 0.514
Branches/plant							1.000	- 0.561
Weed weight								1.000

Values above 0.308 are significant at P = 0.05 probability level.

Table 12. Correlation between weed weight, crop growth and pepper fruit yield and yield attributes as affected by period of weed interference at Samaru in 1982/83 dry season.

	Fruit		Flower	Crop growth				Weed
	Yield	Number	Number	Crop vigour	Plant height	Leaf number	Branches/plant	weight
Fruit yield	1.000	0.558	0.277	0.622	0.294	0.059	0.033	- 0.391
Fruit number		1.000	0.162	0.779	0.307	0.147	0.206	- 0.625
Flower number			1.000	0.258	0.339	0.361	0.163	- 0.071
Crop vigour				1.000	0.318	0.127	0.104	- 0.558
Plant height					1.000	0.251	0.265	- 0.050
Leaf number						1.000	0.036	0.030
Branch/plant							1.000	0.144
Weed weight								1.000

Values above 0.308 are significant at P = 0.05 probability level.

Table 13. Correlation between weed weight, crop growth and yield and yield attributes as affected by period of weed interference at Kadawa in 1982/83 dry season.

	Fruit		Flower	Crop growth				Weed
	Yield	Number	Number	Crop vigour	Plant height	Leaf number	Branches/plant	weight
Fruit yield	1.000	0.707	0.011	0.737	0.042	0.182	0.769	- 0.734
Fruit number		1.000	0.372	0.710	0.292	0.027	0.379	- 0.553
Flower number			1.000	0.042	0.472	0.420	0.206	- 0.070
Crop vigour				1.000	0.136	0.120	0.657	- 0.734
Plant height					1.000	0.316	0.143	- 0.001
Leaf number						1.000	0.274	- 0.344
Branch number							1.000	- 0.701
Weed weight								1.000

Values above 0.308 are significant at P = 0.05 probability level.

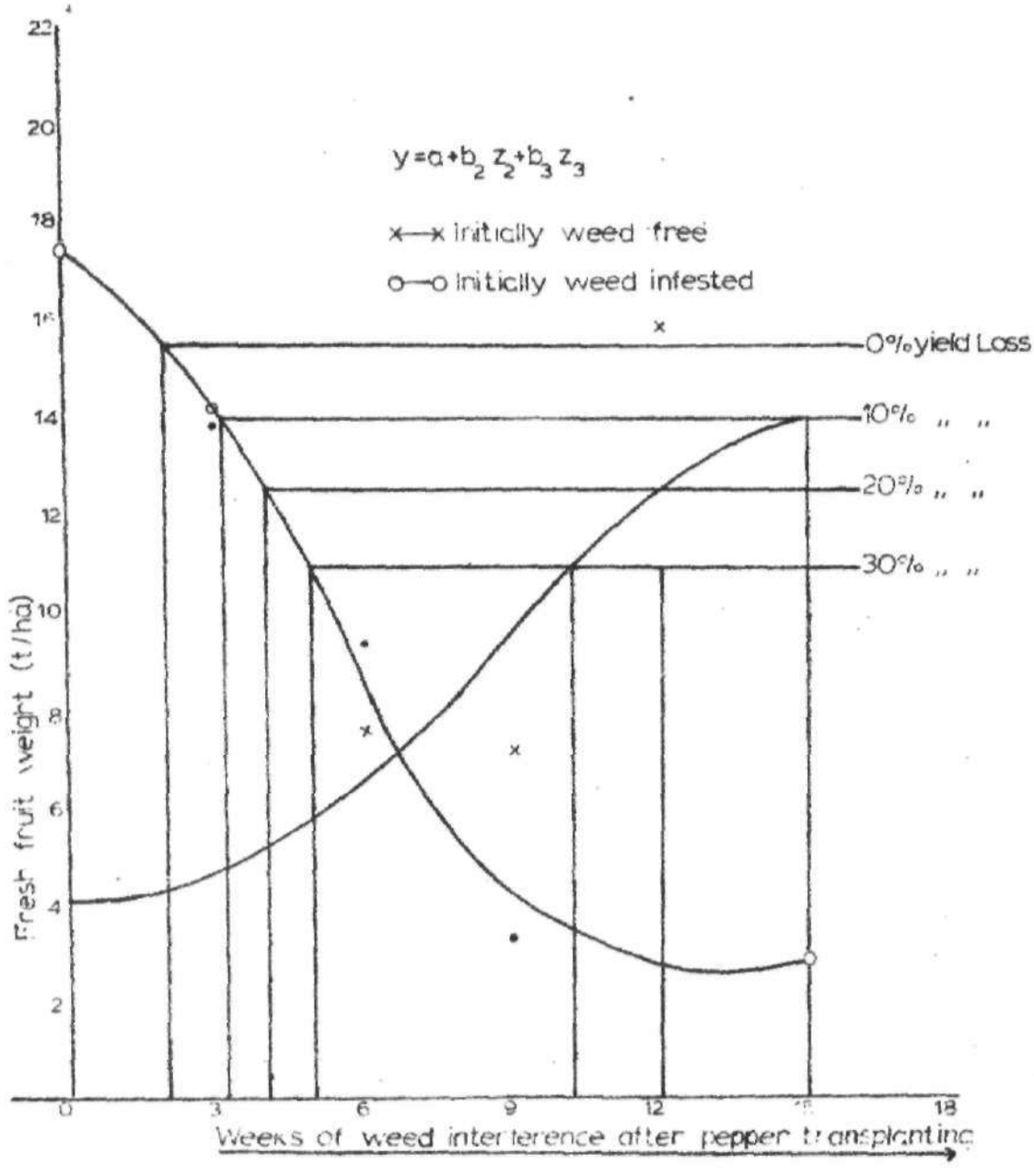


Figure 1 Fitted values of fresh fruit yeild as affected by period of weed interference in sweet pepper at Samaru during the wet season in 1982.

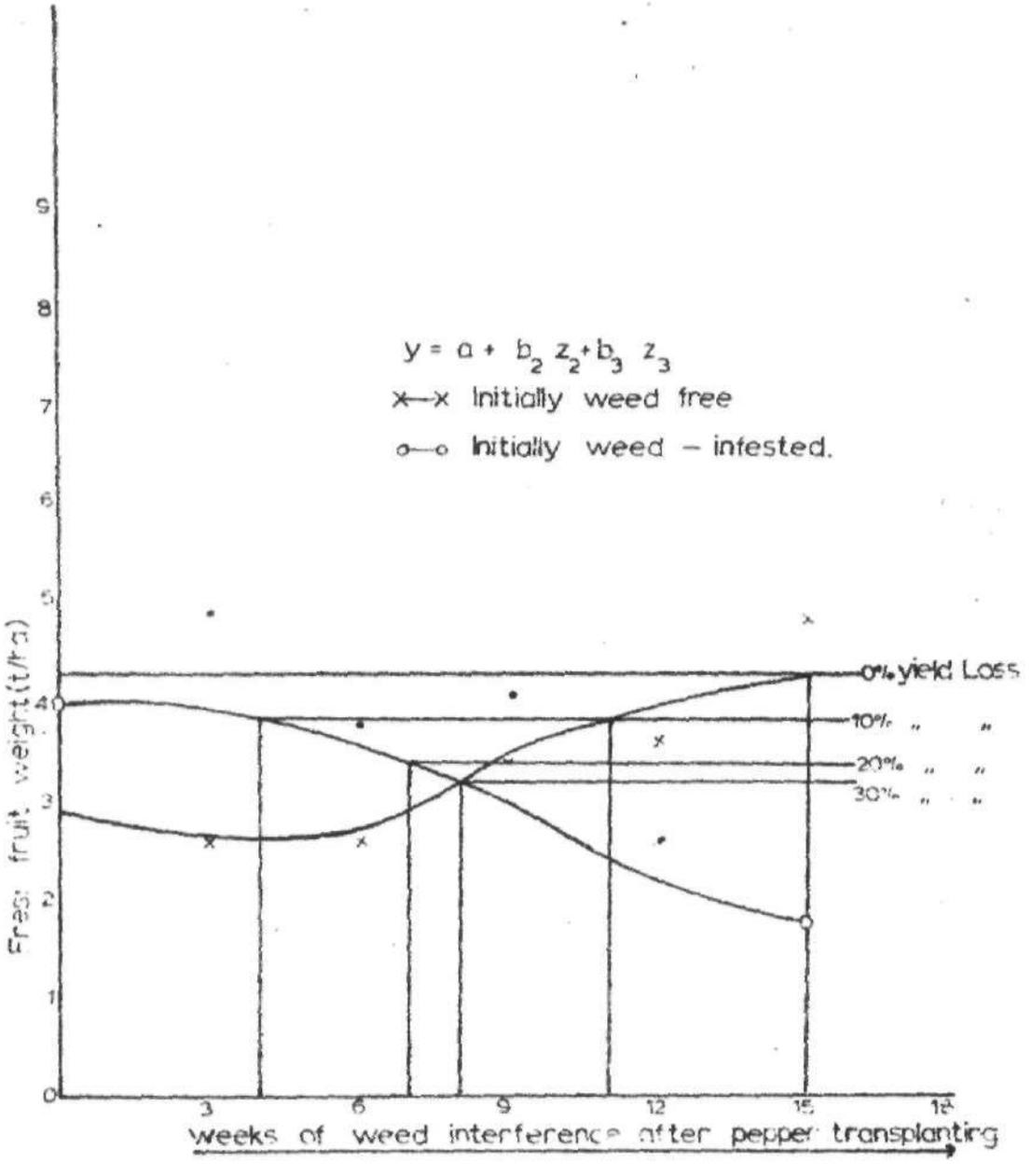


Figure 2 Fitted values of fresh fruit yield as affected by period of weed interference in sweet pepper at Samaru in 1982/83.

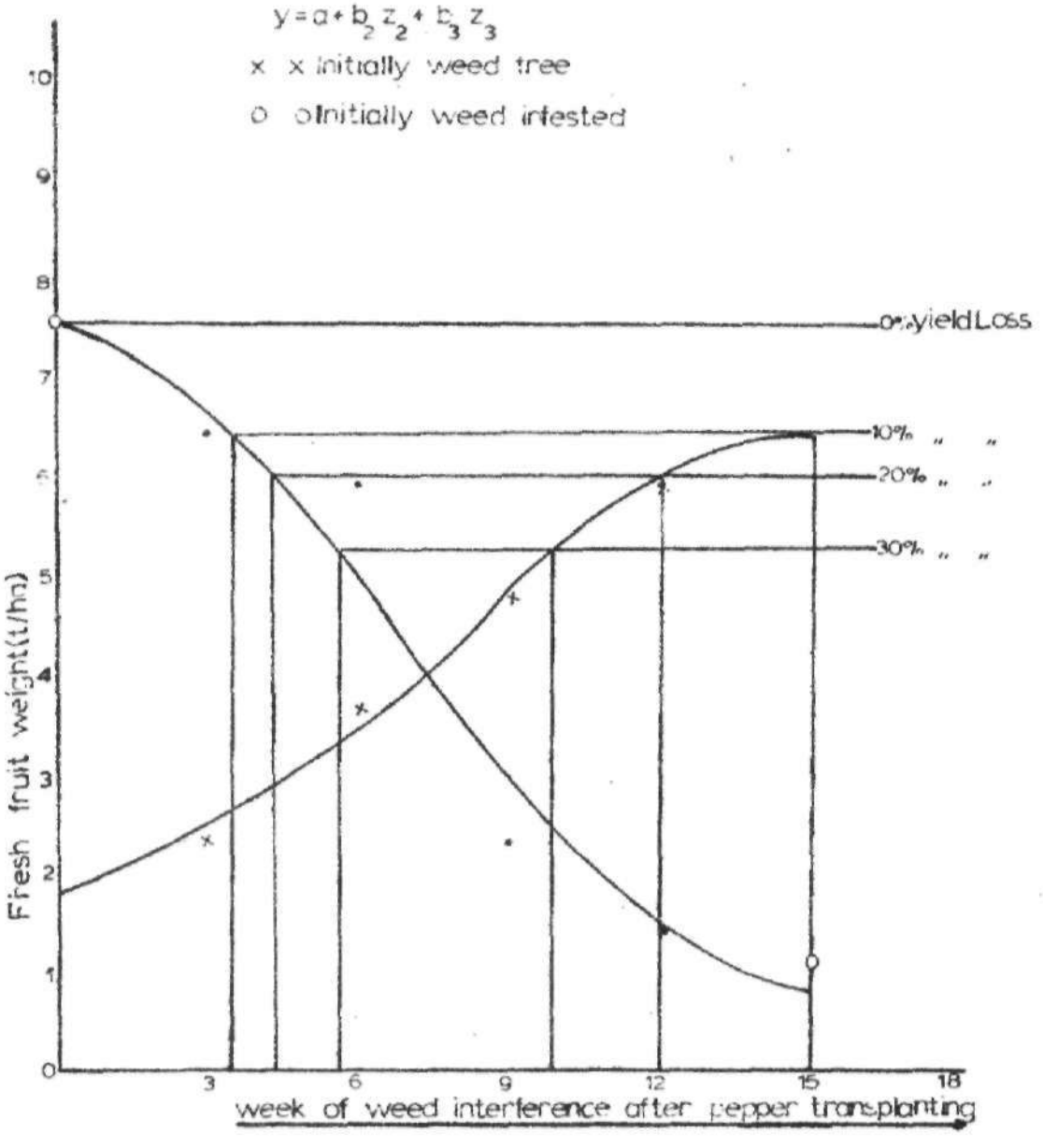


Figure 3 Fitted values of fresh fruit yield as affected by period of weed interference in sweet pepper at Kadawa in 1982/83 dry season.

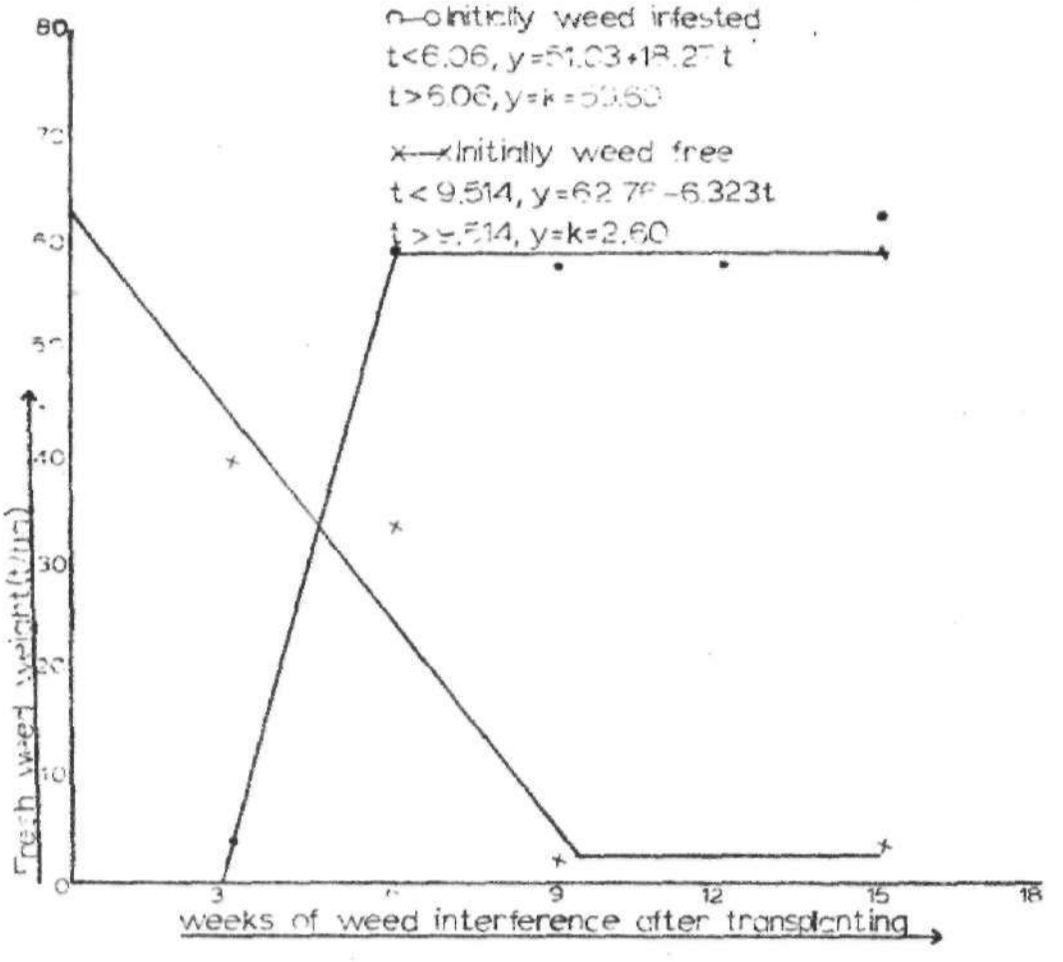


Figure 4 Fitted values of fresh weed weight as affected by period of weed interference in sweet pepper at Samaru in 1982 wet season.

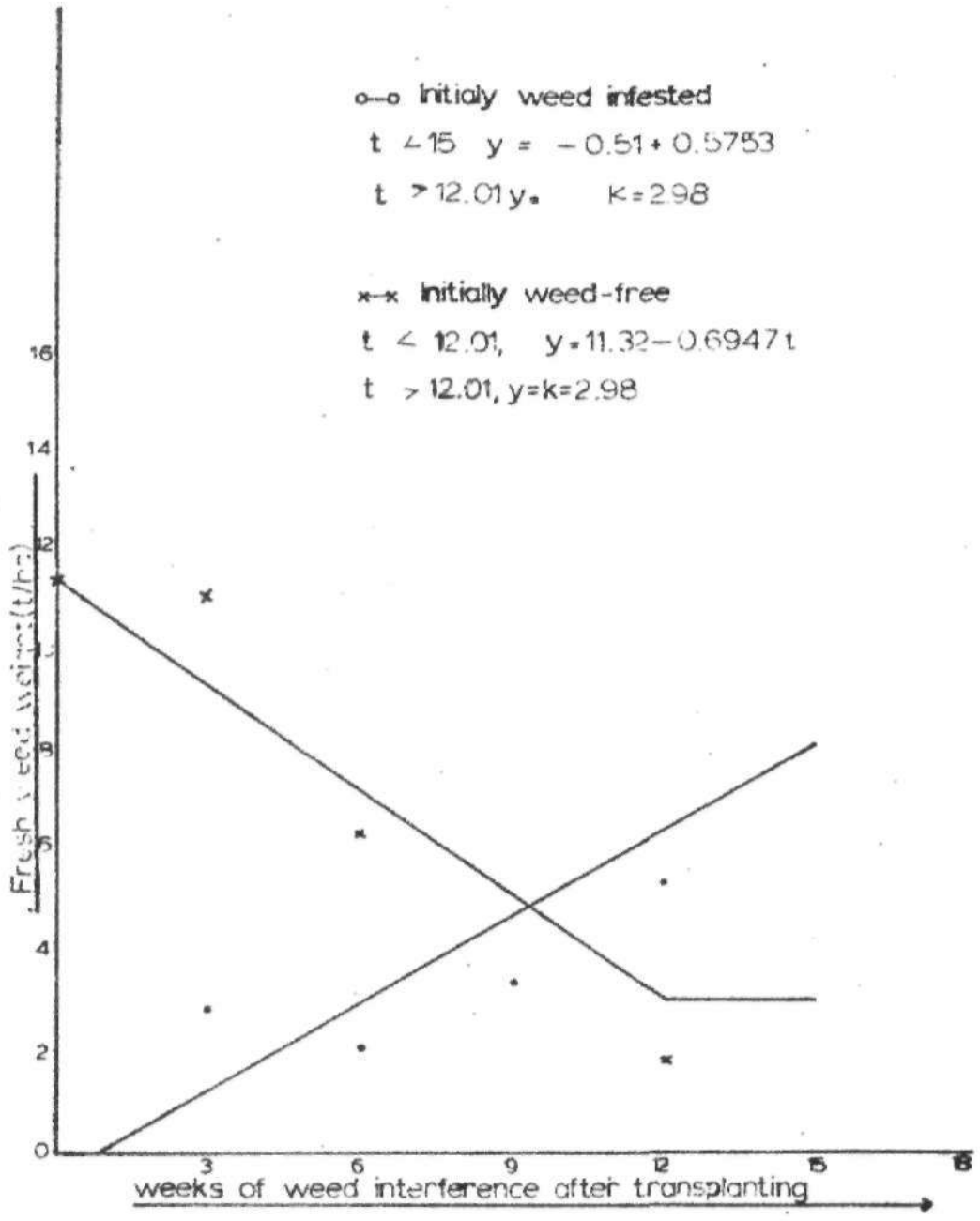


Figure 5 Fitted values of fresh weed weight as affected by period of weed interference in sweet pepper at Samaru in 1982/83 dry season.

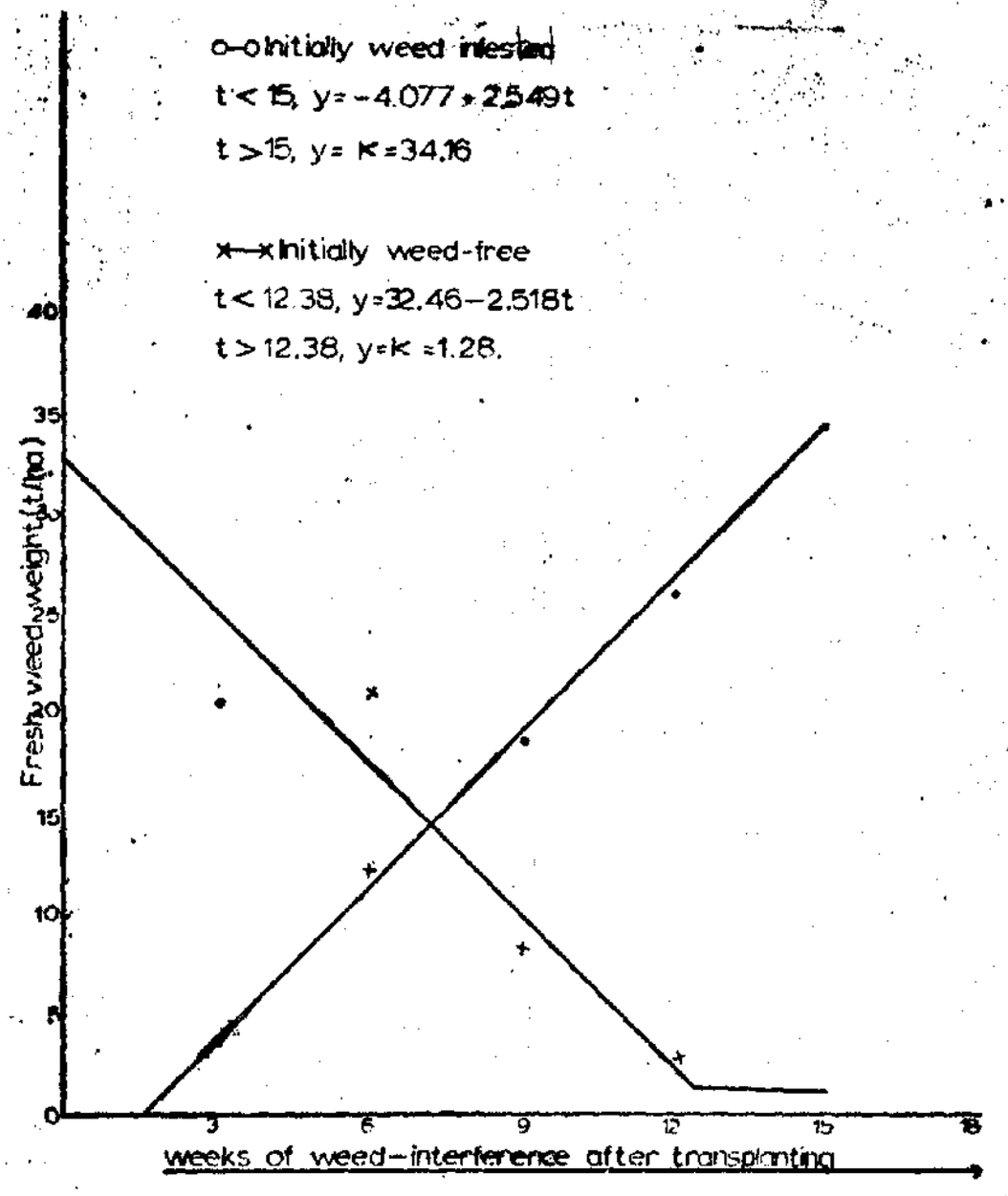


Figure 6 Fitted values of fresh weed weight as affected by period of weed interference in sweet pepper at Kadawa in 1982/83 dry season.

.?. 4.2. Effects of herbicide treatments on weeds and pepper

The effect of various herbicide treatments on weed cover score, weed weight, chilli pepper growth and fruit yield are shown in tables 14, 15, 16, 17, 18 and 19.

4.2.1. Weed score

As shown in table 14, during the wet season at Samaru, all the herbicide treatments resulted in lower weed cover score than the unweeded control at 3 and 6 WAT. However, at 6 WAT, mixtures of alachlor, metolachlor and chlorthal-dimethyl with linuron at 1.0 + 0.5, 2.0 + 0.5 and 6.0 + 0.5 kg a.i./ha, respectively, alachlor, metolachlor and chlorthal-dimethyl mixtures with metobromuron each at both rates and pendimethalin plus metobromuron at 1.0 + 1.0 kg a.i./ha resulted in significantly higher weed score than the better hoe-weeded control. Although no herbicide treatment resulted in comparable weed cover score to the hoe-weeded control at 9 WAT during the wet season, all the herbicide treatments except alachlor plus metobromuron at 2.0 + 1.0 and chlorthal-dimethyl mixture with metobromuron at both rates gave lower weed cover score than the unweeded control (Table 14). High rate of diphenamid plus linuron also resulted in lower weed score than the low rate.

During the dry season, all the herbicide treatments except alachlor plus chlorbromuron at 1.0 + 1.0 kg a.i./ha and oxadiazon plus linuron at 1.0 + 0.5 kg a.i./ha resulted in lower weed cover score than the unweeded control at 3, 6 and 9 WAT. Mixtures of linuron with alachlor, diphenamid and pendimethalin at low rates, with metolachlor at both rates and with oxadiazon at 0.5 + 2.0 kg a.i./ha, diphenamid plus metobromuron at 6.0 + 1.0 kg a.i./ha and metolachlor plus metobromuron at 1.0 + 1.0 kg a.i./ha also resulted in higher weed cover score than the better hoe-weeded control at 6 and 9 WAT. The effectiveness of mixtures of linuron with alchlor, diphenamid and pendimethalin at 0.5 + 2.0, 0.5 + 6.0 and 0.5 + 2.0 kg a.i./ha, respectively and metobromuron mixture with diphenamid and pendimethalin at 1.0 + 6.0 and 1.0 + 2.0 kg a.i./ha did not persist until 9 WAT and these treatments resulted in higher weed cover score compared with the better hoe-weeded control. Inspite of the high weed cover scores observed at 9 WAT, scores obtained with alachlor mixture with chlorbromuron at 2.0 + 1.0 kg a.i./ha, alachlor plus metobromuron at 1.0 + 1.0 and 2.0 + 1.0 kg a.i./ha, metolachlor mixture with metobromuron at 2.0 + 1.0 kg a.i./ha, oxadiazon mixture with linuron and metobromuron at 2.0 + 0.5 and 2.0 + 1.0 kg a.i./ha respectively and pendimethalin mixture with linuron at 2.0 + 0.5 kg a.i./ha were similar to that of the hoe-weeded control.

Table 14. Effect of herbicides on weed cover score and weed weight in chilli pepper at Samaru during the wet season in 1982.

Treatment	Rate (kg a.i./ha)	Weed cover score[1] 3 WAT	6 WAT	9 WAT	Fresh weed weight at harvest (t/ha)
Alachlor + linuron	1.0 + 0.5	2.8	6.5	8.4	5.6
Alachlor + linuron	2.0 + 0.5	0.5	5.1	7.6	6.4
Alachlor + metobromuron	1.0 + 1.0	1.8	5.9	8.4	6.1
Alachlor + metobromuron	2.0 + 1.0	4.3	7.3	9.3	7.8
Diphenamid + linuron	4.0 + 0.5	1.5	5.4	7.4	7.2
Diphenamid + linuron	6.0 + 0.5	1.0	3.5	5.1	4.1
Diphenamid + metobromuron	4.0 + 1.0	1.8	5.0	7.3	4.8
Diphenamid + metobromuron	6.0 + 1.0	1.8	4.8	7.6	6.3
Metolachlor + linuron	1.0 + 0.5	2.8	5.4	7.3	5.7
Metolachlor + linuron	2.0 + 0.5	2.8	6.0	7.6	6.7
Metolachlor + metobromuron	1.0 + 1.0	3.0	6.3	8.4	5.3
Metolachlor + metobromuron	2.0 + 1.0	3.5	5.9	8.8	6.7
Pendimethalin + linuron	1.0 + 0.5	1.3	4.9	7.8	5.7
Pendimethalin + linuron	2.0 + 0.5	2.0	5.3	7.4	7.3
Pendimethalin + metobromuron	1.0 + 1.0	3.0	6.4	8.9	7.0
Pendimethalin + metobromuron	2.0 + 1.0	1.8	5.0	7.9	6.1
Oxadiazon + linuron	1.0 + 0.5	1.0	4.1	6.4	4.7
Oxadiazon + linuron	2.0 + 0.5	1.5	4.3	7.1	6.0

Table 14 contd.

Oxadiazon + metobromuron	1.0 + 1.0	0.8	4.8	7.5	5.9
Oxadiazon + metobromuron	2.0 + 1.0	1.0	5.1	7.5	6.2
Dimethametryn + linuron	1.0 + 0.5	0.3	3.8	6.3	3.9
Dimethametryn + linuron	2.0 + 0.5	0.5	4.8	7.1	5.6
Dimethametryn + metobromuron	1.0 + 1.0	0.3	4.8	7.3	7.7
Dimethametryn + metobromuron	2.0 + 1.0	1.5	5.0	8.9	5.8
Metolachlor + chlrobromuron	1.0 + 1.0	1.5	4.8	7.1	5.9
Metolachlor + chlorbromuron	2.0 + 1.0	0.8	4.6	7.5	4.1
Alachlor + chlorbromuron	1.0 + 1.0	1.0	3.9	6.5	3.8
Alachlor + chlorbromuron	2.0 + 1.0	1.0	4.1	7.3	5.2
Chlorthal-dimethyl + linuron	6.0 + 0.5	2.0	5.9	8.5	6.8
Chlorthal-dimethyl + linuron	8.0 + 0.5	1.0	5.5	7.6	6.7
Chlorthal-dimethyl + metobromuron	6.0 + 1.0	4.0	6.3	9.4	7.3
Chlorthal-dimethyl + metobromuron	8.0 + 1.0	4.3	6.1	9.8	6.4
Hoe-weeded at 3 & 6 WAT	-	7.0	4.3	2.0	0.3
Hoe-weeded at 3,6 & 9 WAT	-	7.0	4.9	2.1	0.4
Unweeded check	-	7.5	8.8	10.0	8.7
SE ±		0.72	0.51	0.28	0.90
LSD (at P = 0.05)		2.04	1.44	0.78	2.54

1 Scored on a scale of 0-10, where 0 = no weeds and 10 = full weed cover.

Table 15. Effect of herbicides on weed cover score and weed weight in chilli pepper at Kadawa in 1982/83 dry season.

Treatment		Weed cover score at			Fresh weed weight at harvest (t/ha)
Herbicide	Rate (kg a.i./ha)	3 WAT	6 WAT	9 WAT	
Alachlor + linuron	1.0 + 0.5	4.0	4.0	5.8	19.70
Alachlor + linuron	2.0 + 0.5	3.1	2.5	5.3	13.63
Alachlor + chlorbromuron	1.0 + 1.0	4.3	3.8	5.8	21.75
Alachlor + chlorbromuron	2.0 + 1.0	2.3	2.0	4.0	10.00
Alachlor + metobromuron	1.0 + 1.0	3.1	2.6	4.5	17.63
Alachlor + metobromuron	2.0 + 1.0	2.4	1.9	3.8	8.83
Diphenamid + linuron	4.0 + 0.5	2.8	2.6	5.8	16.25
Diphenamid + linuron	6.0 + 0.5	2.9	2.5	5.8	19.05
Diphenamid + metobromuron	4.0 + 1.0	3.3	2.3	5.3	15.75
Diphenamid + metobromuron	6.0 + 1.0	3.4	2.6	5.3	17.75
Metolachlor + metobromuron	1.0 + 1.0	3.4	3.0	5.8	16.00
Metolachlor + metobromuron	2.0 + 1.0	2.5	2.0	4.3	15.30
Metolachlor + linuron	1.0 + 0.5	3.9	2.6	6.3	19.75
Metolachlor + linuron	2.0 + 0.5	2.8	2.9	6.0	19.50
Oxadiazon + linuron	1.0 + 0.5	5.1	5.3	6.5	21.95
Oxadiazon + linuron	2.0 + 0.5	3.1	2.6	4.8	13.70
Oxadiazon + metobromuron	1.0 + 1.0	3.1	2.3	4.3	9.39
Oxadiazon + metobromuron	2.0 + 1.0	2.1	1.5	4.0	10.80
Pendimethalin + linuron	1.0 + 0.5	3.9	3.1	5.8	19.75
Pendimethalin + linuron	2.0 + 0.5	2.5	1.9	4.5	11.50
Pendimethalin + metobromuron	2.0 + 1.0	3.1	2.4	4.9	11.63

Table 15 contd.

Hoe-weeded at 3 and 6 WAT	-	6.5	1.1	3.5	7.38
Hoe-weeded at 3,6 and 9 WAT	-	4.9	1.4	3.0	4.50
Unweeded check	-	6.0	5.4	7.8	55.35
SE ±	-	0.67	0.50	0.52	3.20
LSD (at P = 0.05	-	1.90	1.41	1.47	9.06

1 Scored on a scale of 0-10, where 0 = no weeds and 10 = full weed cover.

During the wet season at Samaru, weed cover score at 9 WAT was negatively correlated with pepper fruit yield and positively correlated with weed cover score at 6 WAT (r = -0.534 and 0.678, respectively). During the dry season, however, weed cover score at 6 WAT was strongly positively correlated with weed cover score at 9 WAT (r = 0.700).

4.2.2. Total fresh weed weight

Inspite of the supplementary hoe-weeding done at 9 WAT in the wet season, mixture of linuron with high rates of alachlor, diphenamid, metolachlor pendimethalin and chlorthaldimethyl, low rates of linuron with diphenamid and chlorthaldimethyl, mixtures of metobromuron with high rate of alachlor, diphenamid, metolachlor and oxadiazon, metobromuron ixtures with low rate of dimethametryn, high and low rates of chlorthal-dimethyl mixture with metobromuron stil resulted in similar fresh weed weight at harvest to the unweeded control (Table 14). Although non-significant, fresh weed weight in most treatments with high rates of grass weed killer were higher than those of their corresponding treatments with low rate.

In the dry season, all the weed control treatments resulted in lower fresh weed weight than the unweeded control. However, only the high rate of alachlor

mixture with linuron, chlorbromuron and metobromuron, high rate of oxadiazon mixture with linuron both rates of oxadiazon mixture with metobromuron high rate of pendimethalin mixture with linuron and metobromuron resulted in similar fresh weed weight to three hoe-weedings. In addition to the indicated herbicide treatments, mixtures of linuron with alachlor at 0.5 + 2.0 kg a.i./ha diphenamid at 0.5 + 4.0 kg a.i./ha, metolachlor plus metobromuron at both rates and oxadiazon plus linuron at 2.0 + 0.5 kg a.i./ha resulted in similar fresh weed weight to two hoe-weedings.

In the wet season, fresh weed weight was positively correlated with weed cover score at 6 and 9 WAT only (r = 0.428 and 0.540, respectively), while in the dry season it was correlated with weed cover score at 6 and 9 WAT (r = 0.440 and 0.719, respectively).

4.2.3. Crop vigour score

As shown in table 16, in the wet season, mixtures of metolachlor, pendimethalin and dimethametryn with linuron at 1.0 + 0.5, 1.0 + 0.5 and 2.0 + 0.5 kg a.i./ha, respectively, high rate of dimethametryn mixture with metobromuron, both rates of metolachlor mixture with chlorbromuron and chlorthal-dimethyl mixture with metobromuron at 8.0 + 1.0 kg a.i./ha resulted in significantly lower crop vigour score

Table 16. Effect of herbicides on the stand count, height and vigour score of chilli pepper at Samaru during the wet season in 1982.

Treatment		Crop vigour score[1]	Plant height (cm)	Crop stand per plot
Herbicide	Rate (kg a.i./ha)	9 WAT	4 WAT	at harvest
Alachlor + linuron	1.0 + 0.5	7.6	21	14
Alachlor + linuron	2.0 + 0.5	8.5	22	13
Alachlor + metobromuron	1.0 + 1.0	7.8	19	14
Alachlor + metobromuron	2.0 + 1.0	8.0	19	14
Diphenamid + linuron	4.0 + 0.5	8.5	23	13
Diphenamid + linuron	6.0 + 0.5	8.5	24	14
Diphenamid + metobromuron	4.0 + 1.0	8.3	20	13
Diphenamid + metobormuron	6.0 + 1.0	8.4	24	12
Metolachlor + linuron	1.0 + 0.5	6.3	20	14
Metolachlor + linuron	2.0 + 0.5	7.9	17	13
Metolachlor + metobromuron	1.0 + 1.0	8.5	20	14
Metolachlor + metobromuron	2.0 + 1.0	7.6	24	15
Pendimethalin + linuron	1.0 + 0.5	6.6	21	11
Pendimethalin + linuron	2.0 + 0.5	9.0	22	15
Pendimethalin + metobromuron	1.0 + 1.0	7.5	19	13
Pendimethalin + metobromuron	2.0 + 1.0	7.6	19	11
Oxadiazon + linuron	1.0 + 0.5	8.1	16	13
Oxadiazon + linuron	2.0 + 0.5	8.4	20	15
Oxadiazon + metobromuron	1.0 + 1.0	8.0	17	12
Oxadiazon + metobromuron	2.0 + 1.0	7.1	20	13

Table 16 contd.

Dimethametryn + linuron	1.0 + 0.5	7.5	24	10
Dimethametryn + linuron	2.0 + 0.5	5.9	17	10
Dimethametryn + metobromuron	1.0 + 1.0	8.6	16	11
Dimethametryn + metobromuron	2.0 + 1.0	5.8	25	9
Metolachlor + chlorbromuron	1.0 + 1.0	6.4	22	12
Metolachlor + chlorbromuron	2.0 + 1.0	6.4	21	12
Alachlor + chlorbromuron	1.0 + 1.0	7.8	23	12
Alachlor + chlorbromuron	2.0 + 1.0	8.4	19	14
Chlorthal-dimethy + linuron	6.0 + 0.5	7.8	20	14
Chlorthal-dimethyl + linuron	8.0 + 0.5	7.1	16	13
Chlorthal-dimethyl + metobromuron	6.0 + 1.0	7.6	23	13
Chlorthal-dimethyl + metobromuron	8.0 + 1.0	5.9	18	12
Hoe-weeded twice at 3 and 6 WAT		8.9	19	14
Hoe-weeded thrice at 3,6 and 9 WAT		9.5	21	13
Unweeded check		5.4	20	13
SE ±		0.85	2.14	0.96
LSD (at P = 0.05)		2.42	NS	2.71

1 Scored on scale 0-10, where 0 = crop completely killed, and 10 = fully healthy crop.

Table 17. Effect of herbicides on the growth of chilli pepper at Kadawa in 1982/83 dry season.

Treatment		Crop vigour score[1]		Plant height	Number of branches /plant	Crop stands
Herbicide	Rate (kg a.i./ha)	at 6 WAT	9 WAT	5 WAT	at harvest	at harvest
Alachlor + linuron	1.0 + 0.5	6.0	5.5	52.3	35	31
Alachlor + linuron	2.0 + 0.5	4.5	5.8	54.4	47	33
Alachlor + chlorbromuron	1.0 + 1.0	5.4	5.5	50.5	85	29
Alachlor + chlorbromuron	2.0 + 1.0	3.8	4.0	44.8	42	20
Alachlor + metobromuron	1.0 + 1.0	4.8	5.0	47.0	33	27
Alachlor + metobromuron	2.0 + 1.0	4.3	4.8	53.3	44	27
Diphenamid + linuron	4.0 + 0.5	6.5	5.3	41.8	41	32
Diphenamid + linuron	6.0 + 0.5	6.8	6.5	47.8	39	32
Diphenamid + metobromuron	4.0 + 1.0	5.5	5.5	51.3	39	34
Diphenamid + metobromuron	6.0 + 1.0	7.5	7.5	53.8	51	35
Metolachlor + metobromuron	1.0 + 1.0	5.8	4.8	44.8	77	33
Metolachlor + metobromuron	2.0 + 1.0	6.3	6.8	44.0	52	34
Metolachlor + linuron	1.0 + 0.5	6.3	5.5	45.3	68	33
Metolachlor + linuron	2.0 + 0.5	5.4	5.5	47.5	86	35
Oxadiazon + linuron	1.0 + 0.5	5.8	5.8	44.3	73	32
Oxadiazon + linuron	2.0 + 0.5	6.3	6.5	51.3	75	34
Oxadiazon + metobromuron	1.0 + 1.0	6.5	5.8	58.0	71	35

Table 17 contd.

Oxadiazon + metobromuron	2.0 + 1.0	5.8	5.3	48.3	47	34
Pendimethalin + linuron	1.0 + 0.5	6.8	7.0	52.0	59	34
Pendimethalin + linuron	2.0 + 0.5	5.5	6.5	58.3	62	32
Pendimethalin + metobromuron	2.0 + 1.0	6.0	6.0	44.0	58	33
Hoe-weeded at 3 and 6 WAT		7.0	8.8	46.8	48	31
Hoe-weeded at 3,6 and 9 WAT		6.5	7.3	48.3	53	33
Unweeded check		5.8	4.8	45.8	14	26
SE ±		0.45	0.60	3.93	14.07	1.87
LSD (at P = 0.05)		1.28	1.70	NS	NS	5.27

1 Score on scale 0-10, where 0 = crop completely killed, and 10 = fully healthy crop.

than the better hoe-weeded control at 9 WAT. Among the herbicide treatments that gave comparable vigour score to the hoe-weeded control, mixtures of alachlor with linuron, chlorbromuron and metobromuron at 1.0 + 0.5, 1.0 + 1.0 and 1.0 + 1.0 kg a.i./ha, respectively, metobromuron mixture with high rates of metolachlor pendimethalin, oxadiazon, low rate of pendimethalin and chlorthal-dimethyl, linuron mixture with dimethametryne and chlorthal-dimethyl at both rates did not differ significantly from the unweeded control. Crop vigour score value of 5.4 obtained with the unweeded control was low compared with the better hoe-weeded control, while the two hoe-weeding treatments had similar crop vigour scores at 9 WAT.

During the dry season, at 6 WAT, mixtures of linuron with high rates of alachlor, metolachlor and pendimethalin, both rates of alachlor mixture with chlorbromuron and metobromuron and low rate of diphenamid mixture with metobromuron resulted in significantly lower crop vigour score than the better hoe-weeded control (Table 17). At this stage of the crop growth, only diphenamid mixture with metobromuron at 6.0 + 1.0 kg a.i./ha resulted in

significantly higher crop vigour score than the unweeded control. At 9 WAT, high rate of diphenamid mixture with linuron and metobromuron, high rate of metolachlor mixture with metobromuron, linuron mixture with oxadiazon and pendimethalin at 0.5 + 2.0 and 0.5 + 1.0 kg a.i./ha, respectively, resulted in vigour score that were comparable to that of the three hoe-weedings and significantly higher than that of the unweeded control.

Crop vigour score was only strongly positively correlated with fruit yield in the wet season (r = 0.725).

4.2.4. Plant height

There was no significant difference in plant heights among the various treatments in both wet and dry season trials, but it was positively correlated with number of flowers and branches per plant in the wet season; r = 0.468 and 0.561, respectively (Table 21).

4.2.5. Crop stand count and number of branches per plant

In the wet season trial, pendimethalin mixtures with linuron and metobromuron at 1.0 + 0.5 and 2.0 + 1.0 kg a.i./ha, respectively, both rates of dimethametryn mixture with linuron and metobromuron resulted in significantly lower crop stand count than that of the

better hoe-weeded control (Table 16). In the dry season, both rates of alachlor mixture with chlorbromuron and metobromuron resulted in significantly lower crop stand count than three hoe-weedings. Crop stand count was positively correlated with fruit yield and crop vigour score in the two trials; r values were 0.436 and 0.415, respectively for the wet season and 0.455 and 0.496, respectively for the dry season trials.

There was no significant difference in number of branches per plant among the various treatments applied, both in the wet and dry seasons (Table 16). However, the number of branches per plant was positively correlated with flower number and plant height in the wet season (r = 0.641 and 0.561, respectively).

4.2.6. Pepper fruit number per plant and fruit yield

The effect of weed control treatments on fruit number was significant during the wet season at Samaru (Table 18). Diphenamid plus linuron at both rates, metolachlor plus linuron at 1.0 + 0.5 kg a.i./ha, pendimethalin plus metobromuron at 2.0 + 1.0 kg a.i./ha, alachlor plus chlorbromuron at 1.0 + 1.0 kg a.i./ha and the hoe-weeding treatments resulted in higher fruit number than the unweeded control (Table 18). Among the indicated herbicide treatments, only metolachlor plus linuron at 1.0 + 0.5 kg a.i./ha and alachlor plus

Table 18. Effect of herbicides on chilli pepper fruit number and yield at Samaru during the wet season in 1982.

Treatment		Fruit number* at harvest	Pepper fruit yield
Herbicide	Rate (kg a.i./ha)	No/plant	(t/ha)
Alachlor + linuron	1.0 + 0.5	75	6.71
Alachlor + linuron	2.0 + 0.5	93	6.35
Alachlor + metobromuron	1.0 + 1.0	59	4.58
Alachlor + metobromuron	2.0 + 1.0	74	5.89
Diphenamid + linuron	4.0 + 0.5	123	7.10
Diphenamid + linuron	6.0 + 0.5	122	7.25
Diphenamid + metobromuron	4.0 + 1.0	114	6.93
Diphenamid + metobromuron	6.0 + 1.0	56	6.62
Metolachlor + linuron	1.0 + 0.5	136	6.42
Metolachlor + linuron	2.0 + 0.5	81	5.73
Metolachlor + metobromuron	1.0 + 1.0	95	6.67
Metolachlor + metobromuron	2.0 + 1.0	74	6.09
Pendimethalin + linuron	1.0 + 0.5	76	5.32
Pendimethalin + linuron	2.0 + 0.5	104	7.26
Pendimethalin + metobromuron	1.0 + 1.0	75	4.98
Pendimethalin + metobromuron	2.0 + 1.0	123	6.17
Oxadiazon + linuron	1.0 + 0.5	103	8.34
Oxadiazon + linuron	2.0 + 0.5	112	7.21
Oxadiazon + metobromuron	1.0 + 1.0	55	5.31
Oxadiazon + metobromuron	2.0 + 1.0	98	5.73

Table 18 contd.

Dimetha-metryn + linuron	1.0 + 0.5	96	5.38
Dimetha-metryn + linuron	2.0 + 0.5	50	3.57
Dimetha-metryn + metobromuron	1.0 + 1.0	100	5.29
Dimetha-metryn + metobromuron	2.0 + 1.0	71	4.40
Metolachlor + chlorbromuron	1.0 + 1.0	82	5.30
Metolachlor + chlorbromuron	2.0 + 1.0	108	5.30
Alachlor + chlorbromuron	1.0 + 1.0	132	6.75
Alachlor + chlorbromuron	2.0 + 1.0	108	7.86
Chlorthal-dimethyl + linuron	6.0 + 0.5	68	5.79
Chlorthal-dimethyl + linuron	8.0 + 0.5	83	4.48
Chlorthal-dimethyl + metobromuron	6.0 + 1.0	86	4.63
Chlorthal-dimethyl + metobromuron	8.0 + 1.0	79	4.26
Hoe-weeded at 3 and 6 WAT		174	8.49
Hoe-weeded at 3, 6 and 9 WAT		179	9.14
Unweeded check		70	1.23
SE ±		18.32	1.14
LSD (at P = 0.05)		51.84	3.22

Table 19. Effect of herbicides on chilli pepper fruit number and yield at Kadawa during 1982/83 dry season

Treatment		Fruit number per plant at harvest	Pepper fruit yield (t/ha)
Herbicide	Rate (kg a.i./ha)		
Alachlor + linuron	1.0 + 0.5	48	1.11
Alachlor + linuron	2.0 + 0.5	47	1.12
Alachlor + chlorbromuron	1.0 + 1.0	50	0.98
Alachlor + chlorbromuron	2.0 + 1.0	35	0.71
Alachlor + metobromuron	1.0 + 1.0	44	0.98
Alachlor + metobromuron	2.0 + 1.0	24	0.76
Diphonamid + linuron	4.0 + 0.5	97	1.22
Diphenamid + linuron	6.0 + 0.5	48	1.13
Diphenamid + metobromuron	4.0 + 1.0	29	0.71
Diphenamid + metobromuron	6.0 + 1.0	63	1.60
Metolachlor + metobromuron	1.0 + 1.0	34	0.81
Metolachlor + metobromuron	2.0 + 1.0	81	1.83
Metolachlor + linuron	1.0 + 0.5	40	0.93
Metolachlor + linuron	2.0 + 0.5	48	0.82
Oxadiazon + linuron	1.0 + 0.5	38	0.77
Oxadiazon + linuron	2.0 + 0.5	71	1.62
Oxadiazon + metobromuron	1.0 + 1.0	59	1.28
Oxadiazon + metobromuron	2.0 + 1.0	71	1.47
Pendimethalin + linuron	1.0 + 0.5	69	1.80
Pendimethalin + linuron	2.0 + 0.5	70	1.74

Table 19. contd.

Pendimethalin + metobromuron	2.0 + 1.0	59	1.35
Hoe-weeded at 3 and 6 WAT		81	1.79
Hoe-weeded at 3,6 and 9 WAT		89	1.35
Unweeded check		7	0.14
SE ±		16.13	0.30
LSD (at P = 0.05)		45.60	0.85

chlorbromuron at 1.0 + 1.0 kg a.i./ha and comparable fruit number to three hoe-weedings,. During the dry season, diphenamid plus linuron at 4.0 + 0.5 kg a.i./ha, metolachlor plus metobromuron at 2.0 + 1.0 kg a.i./ha, oxadiazon plus linuron at 2.0 + 0.5 kg a.i./ha, oxadiazon plus metobromuron and pendimethalin plus linuron each mixture at both rates and pendimethalin plus metobromuron at 2.0 + 0.5 kg a.i./ha and the two hoe-weeding treatments had significantly higher fruit number than the unweeded control (Table 19). Among the herbicide treatments indicated, diphenamid plus linuron at 4.0 + 0.5 kg a.i./ha and metolachlor plus metobromuron at 2.0 + 1.0 kg a.i./ha had comparable fruit number to three hoe-weedings, while in addition, pendimethalin plus linuron at both rates and high rates of oxadiazon mixture with linuron and metobromuron resulted in similar fruit number to two hoe-weedings.

In the wet season, fruit number was positively correlated with fruit yield and negatively correlated with weed cover score at 9 WAT ($r = 0.602$, and -0.432, respectively). In the dry season, number of fruits per plant was positively correlated with only fruit yield ($r = 0.810$) (Table 20).

The data on fruit yield in both trials are presented in tables 18 and 19. In the wet season, only the high rates of dimethametryn mixture with either linuron or metobromuron and chlorthal-dimethyl mixture with metobromuron

resulted in very low fruit yields that did not differ significantly from that of the unweeded control probably due to phytotoxicity. However, fruit yields obtained with alachlor mixture with metobromuron at high rate, diphenamid mixture with either linuron or metobromuron at both rates, metolachlor mixture with metobromuron at both rates, high rate of pendimethalin mixture with either linuron or metobromuron, both rates of oxadiazon mixture with linuron and alachlor mixture with chlorbromuron at both rates were similar to three hoe-weedings. In addition fruit yields obtained with alachlor plus metobromuron at 2.0 + 1.0 kg a.i./ha, linuron mixture with metolachlor and pendimethalin at 0.5 + 2.0 and 0.5 + 1.0 kg a.i./ha, respectively, metobromuron mixture with oxadiazon at both rates low rates of dimethametryn with either linuron or metobromuron, metolachlor mixture with chlorbromuron at both rates and chlorthal-dimethyl mixture with linuron at low rate were comparable to that of plots hoe-weeded twice at 3 and 6 WAT in the wet season.

In the dry season, mixtures of alachlor with chlorbromuron and metobromuron at 1.0 + 1.0 kg a.i./ha metobromuron mixtures with diphenamid and metolachlor at 1.0 + 4.0 and 1.0 + 1.0 kg a.i./ha, respectively, linuron mixture with metolachlor at both rates and oxadiazon mixture with linuron at 2.0 + 0.5 kg a.i./ha resulted in fruit yield that did not differ significantly from that

of the unweeded control and lower than that of three hoe-weedings. All the other herbicide treatments, however, produced similar yield to three hoe-weedings. In this trial unchecked weed growth throughout the crop life cycle resulted in 87 and 90% in pepper fruit yields during the wet and dry season, respectively. As shown in tables 18 & 19, during the wet season, fruit yield was positively correlated with fruit number, crop vigour core, crop stand count and negatively correlated with weed cover score at 6 and 9 WAT ($r = 0.602$, 0.725, 0.436, -0.538 and -0.534, respectively). During the dry season fruit yield was only strongly correlated with fruit number and crop stand count; $r = 0.810$ and 0.455, respectively (Table 21).

Table 20. Correlation between weed weight, crop growth and yield of pepper as affected by chemical weed control at Samaru during the wet season in 1982.

Plant Yield	Number Number	Flower number (6 WAT)	Crop growth: Crop vigour 9 WAT	Crop growth: Plant height 4 WAT	Crop growth: Branches /plant 4 WAT	Crop growth: Stand count 6 WAT	Weed: Score 3 WAT	Weed: Score 6 WAT	Weed: Score 8 WAT	Weed: Weight at harvest
Fruit yield 1.000	0.602	0.268	0.725	0.133	0.315	0.436	-0.136	-0.538	-0.534	-0.119
Fruit number	1.000	0.238	0.384	-	0.151	0.266	-0.029	-0.344	-0.432	-0.018
Flower number		1.000	0.266	0.468	0.641	0.098	-0.008	-0.037	-0.011	-0.092
Crop vigour			1.000	0.192	0.294	0.415	-0.096	-0.332	-0.349	-0.102
Plant height				1.000	0.561	0.137	-0.049	-0.081	-0.014	-0.002
Branches/plant					1.000	0.113	-0.076	-0.065	-0.134	-0.125
Stand count						1.000	0.149	0.535	-0.131	-0.082
Weed score (3 WAT)							1.000	0.535	0.013	0.001
Weed score (6 WAT)								1.000	0.678	0.428
Weed score (8 WAT)									1.000	0.540
Weed weight (at harvest)										1.000

Values above 0.167 are significant at P = 0.05 probability level.

Table 21. Correlation between weed weights, crop growth and yield as affected by chemical weed control in pepper at Kadawa in 1982/83 dry season.

Yield	Fruit Number	Flower number 6 WAT	Crop growth: Crop vigour 6 WAT	Crop vigour 9 WAT	plant height 5 WAT	Crop stand count	Branches /plant at harvest	Weed: Cover Score at 6 WAT	Cover Score at 9 WAT	Weight at harvest
Fruit yield 1.00	0.810	0.258	0.363	0.181	0.193	0.455	0.283	0.321	0.394	-0.306
Fruit number	1.000	0.238	0.389	0.178	0.123	0.347	0.251	0.290	0.361	-0.290
Flower number		1.000	0.340	0.077	0.253	0.106	0.336	0.054	0.127	-0.006
Crop vigour (6 WAT)			1.000	0.024	0.211	0.496	0.151	0.055	0.065	-0.011
Crop vigour (9 WAT)				1.000	0.285	0.048	0.039	0.063	0.160	-0.093
Plant height (5 WAT)					1.000	0.246	0.019	0.093	0.078	-0.002
Stand count						1.000	0.244	0.023	0.054	-0.029
Branches/plant							1.000	0.125	0.035	-0.153
Weed cover (6 WAT)								1.000	0.700	0.640
Weed cover (9 WAT)									1.000	0.719
Weed weight										1.000

Values above 0.308 are significant at 0.05 probability level.

Chapter 5

DISCUSSION

In this study, pepper fruit yields obtained from Samaru during the wet season were higher than those obtained in the dry season, both at Samaru and Kadawa. This was probably due to the cold harmattan weather during the months of December to January which caused initial slow pepper growth and subsequent reduction in fruit yields during the dry season. Similarly, sweet pepper fruit yields obtained at Kadawa were higher than those obtained at Samaru during the dry season. This may be attributed to the effects of transplanting date relative to ambient temperature and irrigation schedule. The crop at Kadawa was transplanted in the month of November when the temperature was still thigh and conductive for active growth. This probably enhanced earlier establishment at Kadawa than Samaru where pepper was transplanted in December when harmattan had already set in. Apart from this, the crop at Samaru suffered some set back during the fruit set due to irregular supply of water because of temporary break-down of water pump. Results of studies by Cochran (1936), Chmela and Vlcek (1974) as well as Olarewaju (1981) also indicated that unfavourable temperature and water supply are the factors causing the dropping of buds, blossoms and small fruits in pepper.

5.1. Effects of period of weed-interference on sweet pepper growth, fruit yield and total weed weight

In these trials, sweet pepper was highly sensitive to weed competition. Weed association with the crop throughout its growth cycle resulted in 81.2% loss in potential sweet pepper fruit yield at Samaru during the wet season, and 59.5% and 82.8% losses in fruit yield at Samaru and Kadawa, respectively during the dry season. Eshel and Katan (1972) and Taylorson (1965) also reported 56 and 100% losses in pepper fruit yield due to unchecked weed growth, respectively. In Nigeria, Olaleye (1982) and Falalu (1983) respectively reported 90% and 100% losses in pepper fruit yield when weeds were allowed to compete with the crop throughout its life cycle.

In the dry season, greater loss in pepper fruit yield due to unchecked weed growth throughout the crop growth was observed at Kadawa compared with Samaru probably due to earlier and higher weed infestation at Kadawa than that of Samaru as reflected in the weed weight (Table 10). Fresh weed weight from the plots kept unweeded throughout the crop growth at Kadawa and Samaru during the dry season were 34.4 and 9.9 t/ha, respectively (Table 10). The most prominent weed species at Kadawa were broad-leaved weeds. Such weeds include

Vernonia ambigua (L.), Cleome ciliata (Schum & Thonn), Portuleca oleraceae (L.), Solanum nigrum (L.) Amaranthus spinosus (L.) and Hyptis odoratum (L.). Although some of the above-named weed species were also present in minor number at Samaru in the dry season, the dominant weed species at this site were mainly grasses and sedges such as Eleusine indica (L.) Gaert, Imperata cylindrica (L.) Beauv, Cyperus rotundus (L.) and Cyperus esculentus (L.). It is possible that the high broad-leaved weed infestation at Kadawa resulted in higher fruit yield reduction than the less rapidly growing grasses and sedges at Samaru in the dry season. Early and prolonged rapid weed growth between 2 and 15 WAT at Kadawa (Figure 6) must have encouraged more serious weed competition with the crop and caused greater yield reduction observed at Kadawa. At Samaru in the dry season, rapid weed growth did not occur until between 9 and 12 WAT after the crop had been well established though still susceptible to weed competition (Table 10). The effect of this late weed infestation was however less detrimental to the crop at Samaru.

In all the trials, initial weed infestation with the crop for only 3 WAT did not have any significant effect on any of the crop growth parameters and pepper fruit yield, provided the weeds were subsequently removed.

This was probably because weeds were not yet well established and hence could not compete seriously with the crop at this time. Even in the wet season, only the grass weed seedlings and few annual broad-leaved weeds were present at this initial stage of the crop growth. Such weeds, with only rudimentary root system and few leaves could not compete vigorously with the crop. Hence the presence of weeds at this early stage of the crop growth was non-detrimental provided they were removed thereafter. Although weed infestation until 6 WAT depressed the crop vigour score, this effect was not reflected in pepper fruit yield when the weeds were subsequently removed. However, initial weed infestation for further 3 WAT beyond the first 6 WAT, significantly depressed various crop growth parameters such as crop vigour score, number of leaves and branches per plant and plant height and yield attributes including fruit number and fresh weight compared with the crop kept weed-free throughout its growth. This coincides with the period of rapid weed growth as evident in the weed weight (Table 10). For example, the weed weight of 58.1 t/ha obtained from the plots initially weed-infested for 9 WAT at Samaru during the wet season was not significantly different from 63.0 t/ha obtained from the unweeded plot at the same site. Similarly at Kadawa, the 19.3 t/ha of fresh weed weight

did not differ significantly from 34.4 t/ha obtained from the plots weed-infested throughout the crop growth. This high weed infestation was possibly responsible for significant depression of both crop growth parameters and the fruit yield. In all the trials, once the weeds were allowed to infest the crop until 9 WAT and later, subsequent weed removal did not improve pepper fruit yield significantly compared with that of the unweeded control.

Crops kept weed-free for the first 3 and 6 WAT only in the wet and dry seasons, respectively had significant reduction in fruit yield because of subsequent high weed infestation as reflecte in the fresh weed weight (Table 10). This suggests that initial weed removal for the first 3 and 6 WAT during the wet and dry seasons respectively, was not adequate for optimum fruit yield at the sites of these trials. In order to obtain comparable yield to the weed-free control in the wet season at Samaru, it was required to keep the crop weed free for 6 WAT and beyond. In the dry season, however, both at Samaru and Kadawa, only crops kept weed free beyond 6 and 9 WAT, respectively resulted in comprable fruit yield to the weed-free control. The relatively long weed-free period requirement in the dry season was probably because the weeds emerged later, such that earlier

removal was not useful in obviating their competition.

Yield obtained from plots initially weed-infested for the first 6 WAT and earlier were higher than those obtained from plots initially weeded for the same period. This is probably because late weed competition during the dry season was more important than early competition when most of the broad-leaved weeds had not yet emerged as evident from the weed weight in Table 10.

Figures 1 to 3 contain curves on predicted values of pepper yield using appropriate regression equations, taking into consideration the asymptotic relationship between the period of weed interference and crop yield. In the wet season at Samaru, it was obvious that for 0% 10% and 20% losses in potential pepper fruit yields, weed-free period requirement was 2 WAT until harvest, 3 WAT until harvest and 4 to 12 WAT, respectively (Fig. 1). In the dry season, at the same site, plots aught to be kept weed-free from the time of transplanting of pepper until harvest, 4 to 12 WAT and 7 to 10 WAT, respectively for yield losses indicated above. At Kadawa in the dry season, it was required to keep plots weed-free from the time of transplanting pepper until harvest, 4 to 11 WAT and 7 to 8 WAT for 0%, 10% and 20% losses in fruit yield, respectively.

5.1.2. Critical period of weed competition

As shown in figures 1 to 3 the critical period of weed competition was between 6 and 9 WAT in all the trials. Olaleye (1982), however observed that the critical period of weed competition in sweet pepper was between 3 and 6 WAT. The descripancy may be attributed to differences in the onset of rapid weed growth which was mainly dependent on rainfall in the wet season. While Olaleye (1982) transplanted pepper with early rain which also enhanced early emergence and growth of weeds, pepper seedlings were transplanted later in this trial during the period when rain had ceased temporarily. During this time, the crop was supplied with water directly at the expense of weeds. This might have caused some delay in the onset of competition of weeds with the crop. Hence the critical period of weed competition was delayed until between 6 and 9 WAT pepper. This period also coincides with the time when weeds were most rapidly growing (Figures 4 to 6) and having maximum competition with the crop for moisture, light and nutrients. Hence if the crop was allowed to be infested with weeds for a further 3 WAT beyond the first 6 WAT, subsequent weed removal did not improve its yield significantly compared with the unweeded control. Nieto et al (1968) stated that the critical period of weed competition is influenced

by a number of factors such as the relative rate of growth of the crop and weeds, weed flora, density of planting, the variety of the crop grown and the time of moisture and nutrient stress. Lagoke (1978) also reported that the degree of weed control required would depend on the time of planting. When maize was planted at the beginning of the growing season (i.e. in April) a longer weed-free period of 42 days was required for optimum grain yield since weeds had just started emerging then, while only 33 days was required in the crop planted in May when weeds were rapidly emerging and growing. Sweet pepper fruit yield was highly and positively correlated with fruit number and crop vigour score in all the trials. In addition, it was positively correlated with plant height, number of leaves and branches per plant and negatively correlated with weed weight in the wet season at Samaru, while it was positively correlated with branches and negatively correlated with weed weight at Kadawa in the dry season.

Determination of critical period for weed competition is very important in planning an efficient chemical and cultural weed control programme. The results of this study indicate that initial weed removal in pepper for the first 6 and 9 WAT and later in the wet and dry seasons, respectively, resulted in fruit yield comparable to that of weed-free control.

Hence, it is desirable to identify pre-transplant herbicide treatments which can keep the crop weed-free for the first 9 WAT. This may then be followed by supplementary hoe-weeding or by the use of post-transplant herbicide treatments in order to obtain clean field provided such herbicides are potent on the already emerged weeds. The post-transplant herbicides are particularly desirable in controlling the broad-leaved weeds which normally emerge later in the growing season. The use of such herbicides will also help to extend the period and spectrum of weed control.

5.2. Effect of herbicide treatments on weeds and pepper.

In these trials, all herbicide treatments were supplemented with one hoe-weeding at 9 and 10 WAT during the wet and dry seasons, respectively. Herbicides which combine effective weed control with high pepper fruit yields comparable with three hoe-weedings at Samaru during the wet season include alachlor mixture with either linuron at 1.0 + 0.5 or chlorbromuron at 1.0 + 1.0 and 2.0 + 1.0 kg a.i./ha, diphenamid mixture with linuron and metobromuron at 6.0 + 0.5 and 4.0 + 1.0 kg a.i./ha, respectively, metolachlor mixture with linuron and metobromuron at 1.0 + 0.5 and 1.0 + 1.0 kg a.i./ha, pendimethalin plus

metobromuron at 2.0 + 1.0 kg a.i./ha, and oxadiazon plus linuron at 1.0 + 0.5 and 2.0 + 0.5 kg a.i./ha. The excellent performance of these herbicides was probably due to their ability to control weeds effectively even at harvest as evident from the weed weight without causing serious injury to the crop (Tables 14 & 16). Several workers have similarly reported effective weed control and high pepper fruit yield with diphenamid, alachlor, oxadiazon, pendimethalin and metolachlor either singly or in mixture with other herbici herbicides. (Orsenigo and Ozaki, 1965; Americanos, 1976; Uwannah, 1982; Idris, 1983).

Although alachlor mixture with linuron at 2.0 + 0.5 kg a.i./ha, mixtures of diphenamid with linuron and metobromuron at 4.0 + 0.5 and 6.0 + 1.0, respectively, metolachlor mixture with metobromuron at 2.0 + 1.0 and pendimethalin plus linuron at 2.0 + 0.5 kg a.i./ha resulted in high pepper fruit yield comparable to three hoe-weedings, they did not cause significant reduction in weed weight compared with the unweeded control during the wet season. The high pepper fruit yield obtained with these herbicides was probably because they caused significant weed reduction until 9 WAT.

Despite the effective weed control obtained with pendimethalin plus linuron at 1.0 + 0.5 kg a.i./ha, oxadiazon mixture with metobromuron at 1.0 + 1.0 and 2.0 + 1.0 kg a.i./ha, dimethametryn mixture with

linuron and metobromuron at 2.0 + 0.5 and 2.0 + 1.0 metolachlor plus chlorbromuron at 1.0 + 1.0 and 2.0 + 1.0 kg a.i./ha, pepper fruit yields obtained with these treatments were not comprable with that of the hoe-weeded control. This is probably because the herbicide treatments initially depressed crop growth as reflected in the crop vigour score (Table 13). The poor pepper fruit yields obtained with alachlor mixture with metobromuron at 2.0 + 1.0 kg a.i./ha, metolachlor mixture with linuron at 2.0 + 0.5, metobromuron mixture with pendimethalin at 1.0 + 1.0 and dimethamethryn at 1.0 + 1.0 and 1.0 + 2.0, respectively, chlorthal-dimethyl mixture with linuron at 8.0 + 0.5 and metobromuron at both rates in the wet season was probably due to the poor weed control obtained with these treatments as evident from the weed weight (Table 14).

In the dry season at Kadawa, the relatively high fresh weed weight production of 55.4 t/ha obtained from the unweeded control is probably due to constant irrigation which provided favourable condition for the proliferation and rapid growth of broad leaved weeds. Despite this high weed infestation, alachlor mixture with chlorbromuron and metobromuron at 1.0 + 1.0 kg a.i./ha each, diphenamid plus linuron at 4.0 + 0.5 and 6.0 + 0.5 kg a.i./ha, diphenamid mixture with metobromuron

at 6.0 + 1.0 kg a.i./ha, metolachlor plus metobromuron at 2.0 + 1.0, oxadiazon mixture with linuron at 2.0 + 0.5 and metobromuron at 1.0 + 1.0 and 2.0 + 2.0 + 1.0 pendimethalin plus linuron at 1.0 + 0.5 kg a.i./ha, high rate of pendimethalin mixtures with linuron and metobromuron combined effective weed control with high pepper fruit yield comparable with the hoe-weeded control. The effectiveness of these herbicide treatments in the this trial was probably due to the low temperature of the harmattan at the earlier state of the trial which reduced early weed emergence and growth and possibly the rate of degradation of the herbicides, thus extending their period of weed control. Lagoke et al. (1983) also observed that low temperature during the harmattan period enhanced chemical weed control in irrigated tomatoes in the Nigerian Sudan savanna. It appears that the herbicide treatments in this study were much more effective against the early emerging grass weeds than the broad-leaved weeds which emerged later in the season, hence the need for a supplementary hoe-weeding at 9 WAT. Uncontrolled weeds throughout the crop life cycle resulted in 86 to 92% loss in potential chilli pepper yield. Similarly, Lawal (1982) Uwannah (1982) and Nongu (1982) respectively reported 87%, 95% and 94% reduction in potential chill pepper fruit yields at Samaru.

In these trials, pepper fruit yields were positively correlated with fruit number, crop vigour score, crop stand count and negatively correlated with weed cover score at 6 and 9 WAT in the wet season (r = 0.602, 0.725, 0.436, -0.538 and -0.534, respectively), while in the dry season it was only highly and positively correlated with fruit number and crop stand count (r = 0.810 and 0.455, respectively). Nandpuni, Gupta and Thakur (1970) reported that pepper fruit yield was positively correlated with 100-seed weight, fruit size, number of fruits and branches per plant and plant height. Kirth, Bhoop and Naresh (1971) also observed that pepper fruit yield was highly correlated with plant height, number of branches, fruit number, while fruit number was found to be highly and positively correlated with fruit fresh weight, number of branches and plant height.

Chapter 6

SUMMARY AND CONCLUSSIONS

Field trials were conducted to evaluate the effects of period of weed interference and the performance of various herbicides for weed control in sweet pepper (Capsicum annuum L.) and chilli pepper (C. frutescens L.), respectively at Samaru during the wet season in 1982 and at Samaru and Kadawa during 1982/83 dry season.

In the weed competition trial, there were ten treatments which were laid out in a randomized complete block design and replicated four times. In one set of the treatments, plots were kept weed-free for 3, 6, 9 and 12 weeks after transplanting (WAT) 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-infestation and weed-free throughout the crop growth were also included as controls. Weeding was done with the West African hand-hoe.

In the study on chemical weed control, sixteen herbicide, mixtures were evaluated each at two rates, and compared with hoe-weeded and unweeded controls during the 1982 wet season at Samaru. Eleven promising herbicide mixtures selected from those evaluated in the wet season were further tested at Kadawa during the dry season and compared with

hoe-weeded and unweeded controls. The treatments were laid out in a randomized complete block design and replicated four times.

The results obtained from this study indicated, that weed infestation for 9 WAT and later significantly depressed various crop growth parameters such as crop vigour score, number of leaves and branches per plant and yield and yield attributes including fruit number and fruit weight compared with the crop kept weed-free throughout its growth. Although weed association with the crop during the first 6 WAT depressed crop vigour score, this effect was not reflected in sweet pepper fruit yield when the weeds were subsequently removed. Weed association with the crop throughout its growth cycle resulted in 81.2% loss in potential sweet pepper fruit yield at Samaru during the wet season, 59.5% and 82.8% losses at Samaru and Kadawa during the dry season.

In order to obtain statistically comparable fruit yield to that of the weed-free control in the wet season at Samaru, it was required to keep the crop weed-free for 6 WAT and later, although this yield was 52.4% less than the maximum obtainable. In the dry season, only crops kept weed-free beyond 6 and 9 WAT, respectively, at Samaru and Kadawa resulted in comparable fruit yield to the weed-free control. The critical period of weed competition was observed to be between 6 and 9 WAT.

Sweet pepper fruit yield was strongly and positively correlated with number of fruits, leaves and branches per plant, crop vigour score, plant height and negatively correlated with weed weight at Samaru during the wet season ($r = 0.840$, 0.551, 0.699, 0.615, 0.610 and -0.514, respectively). In the dry season at Samaru, fruit yield was positively correlated with fruit number and crop vigour score ($r = 0.558$ and 0.622, respectively) while it was positively correlated with fruit number, crop vigour score, number of branches per plant and negatively correlated with weed weight at Kadawa ($r = 0.707$, 0.737, 0.769 and -0.734, respectively).

Herbicides which combined effective weed control with high pepper fruit yields comparable to three hoe-weedings at Samaru during the wet season included alachlor mixture with linuron at 1.0 + 0.5 kg a.i./ha and chlorbromuron at 1.0 + 1.0 kg a.i./ha and 2.0 + 1.0 kg a.i./ha, diphenamid mixture with linuron and metobromuron at 6.0 + 0.5 kg a.i./ha and 4.0 + 1.0 kg a.i./ha, respectively, metolachlor mixture with linuron and metobromuron at 1.0 + 0.5 kg a.i./ha and 1.0 + 1.0 kg a.i./ha, respectively pendimethalin plus metobromuron at 2.0 + 1.0 kg a.i./ha, oxadiazon plus linuron at 1.0 + 0.5 and 2.0 + 0.5 kg a.i./ha.

Although alachlor mixture with linuron at 2.0 + 0.5 kg a.i./ha, mixtures of diphenamid with linuron and metobromuron at 4.0 + 0.5 kg a.i./ha and 6.0 + 1.0 kg a.i/ha,

respectively, metolachlor mixture with metobromuron at 2.0 + 1.0 kg a.i./ha and pendimethalin plus linuron at 2.0 + 0.5 kg a.i./ha resulted in high pepper fruit yield comprable to that of three hoe-weedings, they did not cause significant reduction in weed weight compared with the unweeded control during the wet season.

Despite the effective weed control obtained with pendimethalin plus linuron at 1.0 + 0.5 kg a.i./ha, oxadiazon mixture with metobromuron at 1.0 + 1.0 and 2.0 + 1.0 kg a.i./ha, dimetha-metryn mixture with linuron and metobromuron at 2.0 + 0.5 and 2.0 + 1.0 kg a.i./ha, respectively, metolachlor plus chlorbromuron at 1.0 + 1.0 and 2.0 + 1.0 kg a.i./ha, pepper yields obtained with these treatments were not comparable with that of the hoe-weeded control.

In the dry season at Kadawa, alachlor mixture with chlorbromuron and metobromuron at 1.0 + 1.0 kg a.i./ha each, diphenamid plus linuron at 4.0 + 0.5 and 6.0 + 0.5 kg a.i./ha, diphenamid mixture with metobromuron at 6.0 + 1.0 kg a.i./ha, oxadiazon plus linuron at 2.0 + 0.5 kg a.i./ha oxadiazon plus metobromuron at 1.0 + 1.0 and 2.0 + 1.0 kg a.i./ha, pendimethalin plus linuron at 1.0 + 0.5 and 2.0 + 0.5 kg a.i./ha, pendimethalin plus metobromuron at 2.0 + 1.0 kg a.i./ha combined effective weed control with high pepper fruit yield comparable with the hoe-weeded control. In this study unchecked weed

growth throughout the crop life cycle resulted in 86.6% and 92.2% reduction in potential fruit yield during the wet and dry seasons, respectively.

Chilli pepper fruit yields were strongly and postively correlated with fruit number, crop vigour score, crop stand count and negatively correlated with weed cover score at 6 and 9 WAT in the wet season ($r = 0.602$, 0.725, 0.436, -0.538 and -0.534, respectively), while in the dry season it was only highly and positively correlated with fruit number and stand count ($r = 0.810$, 0.455, respectively).

REFERENCES

Ambling, H.J. and Turner, J. (1961). The influence of certain chemical weed control treatments in potatoes, tomatoes and peppers. Progress report. Proceedings 14th Southern weed conference pp. 146-148.

Americanos, G.P. (1976). Weed control in pepper, eggplant, beans, squash melons and water melons. Technical paper 14. Agricultural Research Institute, Ministry of Agriculture and Natural Resources, Necosia, Cyprus. pp 4-5.

Anonymous, (1973). Annual Report 1973, Colombia Control Internacional de Agriculture Tropical, Colombia. pp. 103-109.

Anonymous (1975). Weed control in upland crops. Annual Report 1975, International Rice Research Institute, Phillipines, pp 392-394. (Weed Abstract 27(1): Abstr. 67, 1978).

Anonymous (1976). Weed control in transplanted rice. Annual Report 1976. International Rice Research Institute, Phillipines pp 182-183. (Weed Abstract 27 (10) Abstr. 3236 1978).

Anonymous (1980). Production Year Book 1980. Food and Agricultural Organization, Rome, Italy. pp 155.

Anonymous (1982). Guide on pepper production. Extention Guide No 43. Agricultural Extention and Research Liaison Servieces, Ahmadu Bello University, Zaria Nigeria.

Ashton, F.M. and Crafts, A.S. (1973). Mode of action of herbicides. Wiley - Interscience Publication New York and London. 504 pp.

Aston, J.L. (1978). Recent experience with stomp (Penoxalin) herbicide in Tropical and sub-tropical climates. Proceedings 6th East African Weed Science Conference. pp. 104-111.

Audus, L.J. (1976). Herbicides, Physiology, Biochemistry and Ecology. Academic Press London and New York 608 pp.

Bagley, P.C. and Beste, C.E. (1982). Pebulate and other herbicides for transplanted peppers. (Proceedings Northeastern Weed Science Society 1982, Maryland University College, Park. 36: 126-127.

Beste, C.E. (1979). Yellow mitsedge competition in seeded tomatoes. Proceedings Northeastern Weed Science Society 1979. Maryland University College, Park. 33: 107.

Bingham, S.W. (1968). Effect of DCPA on cytology of roots Weed Science, 16: 449-452.

Bingham, W.W. and Shaver, R. (1971). Uptake, translocation and degradation of diphenamid in plants. Weed Science, 19: 636-643.

Blanco, H.G. and Oliveira, H.D. (1971). Duration of competition period between weeds and carrot. Biologo., Brazil 37: 3-7.

Blencome, E.K. and Blencome, J.W. (1970). A selective pre-emergence herbicide for cash crops. Crop Diversification in Malaysia pp 226-234. (Weed Abstract 21(1) Abstr. 542, 1972).

Chmela, V. and Vlcek, F. (1974). The influence of the irrigation on the yield and nutritive value of sweet pepper grown in the polyethylene tunnels. Acta Horti. 35: 101-105.

Chiapirinni, L. (1972). Weed control in tomatoes, peppers and eggplant. Information Agrario, Milano, Italy, 1972. p 22.

Cialone, J.C., Smith, N.S. and Pollack, P.S. (1969). Herbicide evaluation in musk-melons (Cucumis melo) and squash (Cucumis maxima) grown on clear polythylene mulch. In Abstracts Meeting of Weed Science Society of America. 1969.

Cochran, H.L. (1936). Some factors influencing growth and fruit-selling in pepper (Capsicum frutscens L.) Cornell University Agricultural Experimental Station Memoir 190, pp 1-39.

Danielson, L.L. (1969). Suggested guide for weed control United States Department of Agriculture Hand Book 332 pp.

Deal, V.B. and Hess, F.D. (1979). An analysis of the growth inhibitor characteristics of alachlor and metolachlor. In Abstract Meeting of Weed Science Society of America 1979.

Dempsey, A.H. and Fretz, T. (1973). New herbicides for weed control in peppers. Research Report University of Georgia 1973. 10 pp.

Denton, L. and Swarup, V. (1981). Tomato cultivation and its potential in Nigeria. Paper presented at the 6th African Horticultural Symposium, Ibadan, Nigeria. 19-25 July, 1981.

Deuber, R.R., Foster, H.R., Compos, F.P. and Scaranari, H.J. (1977). Herbicides in onion crops. Technical paper No. 47, 20 pp. Institute of Agronomy, Campinus, Brazil.

Eshel, Y. and Katan, J. (1972). Effect of time of application of diphenamid on pepper, weeds and diseases. Weed Science 20: 468-471.

Everaats, A.P. and Satsyati (1977). Critical period for weed competition for potatoes in Java. Proceedings of 6th Asian-Pacific Weed Science Society Conference, Indonesia. pp 172-176.

Everaats, A.P. and Muchtar, T. (1979). Weed competition in Cabbages on Java. Proceedings of 7th Asian-Pacific Weed Science Society Conference Sydney. Australia. pp. 83-86.

Falalu, M.M. (1983). An evaluation of directed post-emergence and post-transplanted herbicides for weed control in okra (Hibiscus esculentus L.) and chilli pepper (Capsicum frutescens L.) mixture in Samaru. Unpublished HND. Thesis College of Agriculture, Ahmadu Bello University, Zaria, Nigeria 58 pp.

Friesen, G.H. (1977). Weed interference in transplanted tomato (Lycopersicon esculentum L.) Weed Science 27(1): 11-13.

Gentner, W.A. (1969). Phytotoxity of demethylated analogs of diphenamid. Weed Science 17: 284-285.

Gluhaich, P. (1980). Herbicide trials on transplanted bell peppers at San Luis California. Proceedings 33rd annual California Weed Conference 1981. 97-103.

Grubben, J.H. (1977). Tropical vegetables and their genetic resources edited by Tindal, H.H. and Williams, J.T. Rome. 197 pp.

Idris, A.O. (1983). An evaluation of some pre-emergence/ pre-transplanted herbicides for weed control in okra (Hibiscus esculentus L.) and chilli pepper (Capsicum frutescens L.) mixture at Samaru. Unpublished HND Tesis. College of Agriculture, Ahmadu Bello University, Zaria, Nigeria. 85 pp.

Ignatov, B. (1972). The effects of some herbicides on different Capsicum varieties grown on calcareous chemozey soil. Gradiraska, Lozarka 9 (2): 61-68. In Horticultural Abstract, Bulgaria 43: Abstr. 667.

Isleib, D.R. (1960). Quackgrass control in potato production. Weeds 8: 631-635.

Kasasian, L. (1963). Tropical Weed control notes. Regional Research Centre. Faculty of Agriculture University of West Indies, Trinida. p. 20.

Kasasian, L. and Seeyave, J. (1969). Critical periods for weed competition. Pest Articles and News Summary 15: 208-212.

Kearney, P.C. and Kaufman, D.D. (1969). Degradation of herbicides Marcel Dekker, Inc. New York 500 pp.

Kirti, S., Bhoop, S. and Naresh, M. (1971). Genetic variability and correlation studies in chillies Journal of Research 2(1): 13-18.

Korosmezei, C. (1979). Post-emergence weed control in non-transplanted red peppers. Novenyvedelem 15 (10): 460-462. (Weed Abstract 30: Abstract 3505, 1981).

Labrada, R. and Paredes, E. (1979). Effectiveness of diphenamid in seed bed of pepper (Capsicum annuum L.) Agrotecnia de Cuba 11 (2): 63-68. (Weed Abstract 30 (11): Abstract 3876, 1981).

Lagoke, S.T.O. (1978). Methods of control of speargrass (Imperata cylindrica L. Beauv.) in maize. Ph.D. Thesis, University of Ibadan, Nigeria. 410 pp.

Lagoke, S.T.O., Choudhary, A.H. and Tanko, Y.M. (1981). Weed control in rainfed groundnuts Arachis hypogea L.) in the guinea savanna ecological zone of Nigeria. Weed Research 21: 119-125.

Lagoke, S.T.O., Sinha, T.D. and Olaleye, E.A. (1983). Chemical weed control in irrigated tomatoes in the Nigerian Sudan Savanna. A paper presented at the 2nd International Conference of the West African Weed Science Society, Abidjan, Ivory Coast. 17-22 October, 1983.

Lagoke, S.T.O., Chandra-Singh, D.J. and Ologunde, O.O. (1983). Pre-emergence weed control in Egusi melon (Citrullus lunatus, Thumb. Mansf.) in the Southern guinea savanna of Nigeria. Crop Protection Journal 2 (2): 235-242.

Lange, A.H. (1969). The effect of eight herbicides on weed control in Solanaceons Crops. Research Progress report. Western Society of Weed Science, University California, USA.

Lawal, K.O. (1982). An evaluation of critical period and effects of weed competition on chilli pepper (Capsicum frutescens L.) in Samaru. HND Thesis. College of Agriculture, Ahmadu Bello University, Zaria.

Lemin, A.L. (1966). Absorption, translocation and metabolism of diphenamid by tomato seedlings. Journal of Agricultural Food Chemistry. 14: 109-111.

Locascio, S.J. (1962). Chemical weed control for commercial vegetable production. Annual report, Florida Agriculture experimental Station 1962 pp 173-174.

Mamtso, D.D. (1983). An evaluation of various pre-emergence and direct post-emergence herbicide treatments for weed control in okra (Hibiscus esculentus L.) in Samaru Unpublished HND Thesis College of Agriculture Ahmadu Bello University, Zaria. Nigeria. 67 pp.

Mani, V.S., Gutman, K.C. and Chakraborty, T.K. 1968. Losses in crop yield in India due to weed growth. Pests Articles and News Summary 14: 376-380.

Martins, H. and Worthing, C.R. (1974). Pesticide Manual British Crop Protection Council Fourth Edition. p. 197.

Medrano, C., Pulgar, R. and Delgado, L. (1980). Evaluation of the methods for weed control in tomatoes at the University of Zulia, Venezuela. Weed Abstract 29, Abstr. 707, 1980).

Moen, M., Jami, T., Himme, M.Y. and Stryckers, J. (1980). Chemical weed control in Capsicum crops in Tunisia. Paper presented at 32nd International Symposium on crop protection (1980). Monastir, Tunisia.

Mohammed, E.S. and Sweet, R.D. (1978). Redroot pigweed (Amaranthus retrofluxus) and tomato (Lycopersicon esculentum) competition studies: Influence of plant densities. (Abstract Meeting of Weed Science Society of America No 62 1978).

Mendt, R.D. and Monaco, T.J. (1979). Prickly sida and cocklabour interference in transplanted peppers Abstract in Proceedings 32nd annual meeting South Weed Science Society (1979). North Carolina State University, Raleigh, USA.

Nandpuri, K.S., Gupta, V.P. and Thakur, P.C. (1969). Variability studies in chillies. Journal of Research 8 (3): 311-315.

Nieto, J.H., Brando, M.A. and Gonzalez, J.T. (1968). Critical periods of the crop growth cycle for competition from weeds. Pests Articles and News Summary 14 (2): 159-166.

Nongu, T.T. (1982). An evaluation of some pre-transplanting herbicides for weed control in chilli pepper (Capsicum frutescens L.) at Samaru. Unpublished HND Thesis. College of Agriculture, Ahmadu Bello University, Zaria, Nigeria. 47 pp.

Ogle, W.L. (1972). Performance of several herbicides for weed control in transplanted tomatoes and peppers. Proceedings 25th annual meeting South Weed Science Society 1972. Carolina, USA.

Olaleye, E.A. (1982). The effects of weeds on growth and fruit yield of pepper and the critical period of weed competition with the crop. Unpublished HND Thesis. College of Agriculture, Ahmadu Bello University, Zaria, Nigeria.

Olarewaju, J.D. (1977). A review of horticultural research in the northern states of Nigeria. Acta Horticultural 53: 151-155.

Olarewaju, J.D. (1981). Significance of horticulture in the success of Green Revolution in Nigeria. A paper presented at the 1st National Seminar on Green Revolution in Nigeria, 1981. Ahmadu Bello University, Zaria, Nigeria.

Olarewaju, J.D. (1981). Effect of water stress on flowering and fruit set in sweet pepper (Capsicum annuum L.). A paper presented at the 6th African Horticultural Symposium 19-25 July, 1981. Ibadan, Nigeria.

Oliver, L.R. and Frans, R.E. (1968). Inhibition of cotton and soybean roots from incorporated trifluralin and persistence in soil. Weed Science 16: 199-203.

Olunuga, B.A. and Akobundu, I.A. (1980). Weed problems and control in field and vegetable crop in Nigeria. In Akobundu, I.O. (Ed.) Weeds and their control in the humid and sub-humid Tropics pp. 138-143. Proceedings of a conference held at the International Institute of Tropical Agriculture, Ibadan, Nigeria. July, 1978. Proceedings Series No. 3, IITA, Ibadan.

Orkwor, G.C. (1981). Studies on weed control in irrigated onions (Allium cepa L.) in Northern Nigeria. Unpublished MSc. Thesis. Ahmadu Bello University, Zaria, Nigeria. 104 pp.

Orsenigo, J.R. and Ozaki, H.Y. (1963). Herbicide evaluation of plantation field laboratory 1962-1963 season. Mimeograph report University of Florida 1963. p 13.

Orsenigo, J.R. and Ozaki, H.Y. (1965). Pepper herbicide experimeriments on lower east coast sandy soils. Proceedings Florida State Horticultural Society 1965. Everglades, Florida 78: 124-130.

Overbeek, J.V. (1964). Survey of the mechanisms of herbicide action. In the Physiology and Biochemistry of herbicides Academic Press, New York and London. 555 pp.

Pelletier, J. (1967). Results of Chemical weed control trials conducted in various vegetable crops. Reprint, Florida Agriculture Exprimental Station, 1967. pp. 520-536.

Pelletier, J. and Coilier, P. (1969). Chemical control of weeds in pepper and tomatoes. France Manual Herbes columa, 1969. Paris France. p. 121-129.

Pereira, A.L., Silua, E.M., Tozani, B. and Burga, C.A. (1980). Effects of herbicides on peppers Capsicum annuum. (Weed Abstract 30: Abstract 10, 1981).

Purseglove, J.W. (1977). Tropical crops: dicotyledons. Longmans London and Harlow. 719 pp.

Perez, E.F. (1970). Maloran 504 its use as a herbicide in tomatoes and chillies; Associacion Latinoamericana de Malezas "ALAM" (y) Mexico, 1970.

Romero, C.E. and Espana, J.M. (1975). Chemical weed control in carrots on the Bosota savannah of columbia. (In Weed Abstract 26 Abstr. 614, 1977).

Saghir, A.R. and Markonllis, G. (1975). Effects of weed competition and herbicides on yield and quality of potatoes. Proceedings 12th British Weed Control Conference London United Kingdom. British Crop Protection Council (1974) Lebanon pp 533-539.

Sambhi, M.S. and Randhawa, K.S. (1976). Herbicidal control of weeds in transplanted chillies. Punjab Horticultural Journal. 16: 146-148. (Weed Abstract 30: Abstr. 123, 1981).

Shadbolt, C.A. and Holm, L.G. (1956). Some quantitative aspects of weed control in vegetable crops. Weeds 4: 111-123.

Sheinbaum, Y. (1978). Sensitivity of solanaceous seedlings to dipping treatment of oxadiazon (Abstract) in 6th annual conference Weed Science Society of Israel. 27: Abstract 199 (1978).

Sinha, T.D., Lagoke, S.T.O. and Olukosi, J.O. (1983). An evaluation of the cost of various weed control treatments in irrigated onion and tomatoes. Proceedings Vth annual conference of Horticultural Society of Nigeria, Ahmadu Bello University, Zaria, Nigeria. Nov. 1982.

Sinha, T.D. and Lagoke, S.T.O. (1982). An evaluation of pre-transplant herbicides for weed control in irrigated onion in northern Guinea and Sudan savanna ecological zones of Nigeria. Crop Protection 2 (4) pp.

Sinha, T.D. and Lagoke, S.T.O. (1983). Weed control in irrigated tomatoes (Lycopersicon esculentum Mill.) in northern Nigeria. Tropical Pest Management 29 (4). pp.

Steel, W.M. (1965). A note on the current situation development and problems of vegetable and grain legume production in northern Nigeria. A paper presented at Food and Agricultural Organization 1st Technical Meeting on Improvement of vegetables and legume production in Africa. Dakar, Senegal, 18-24 January, 1965. p 1.

Sweet, R.D., Bonrano, A.R. and Warholic, T.D. (1980). Alachlor for transplanted vegetables Weed Abstract 29 (12): Abstr. 4029, (1980).

Talbert, R.E., Wallinder, C.J. and Sanders, P.A. (1979). Field evaluation of herbicides in vegetable crops Mimeograph Series Arkansas (1980) No. 281, 12 (en) University of Arkansas, USA.

Taylorson, R.B. (1965). Delayed pre-emergence weed control in seeded tomatoes and peppers. Weeds 20 (4): 306-308.

Uwannah, C.E. (1982). An evaluation of some pre-transplanting herbicides for weed control in chilli pepper. (Capsicum frutescens L.) in Samaru. Unpublished HND Thesis College of Agriculture, Ahmadu Bello University, Zaria, Nigeria. 56 pp.

Wascome, B.J. (1967). Weed control studies in hot pepper. In Proceedings 20th South Weed Science Conference. Southwestern Great Plains Research Centre Bushland, Texas p 146.

Wicks, G.A., Johnston, D.N., Nunland, D.S. and Kinbacher, E.J. (1973). Competition between annual weeds and sweet Spanish onions Weed Science 21: 436-439.

Yusuf, I.I. (1983). An evaluation of combinations of pre-transplant and post-transplant weed control treatments in sweet pepper (Capsicum annuum L.) in Samaru. Unpublished HND Thesis. College of Agriculture, Ahmadu Bello University, Zaria, Nigeria 49 pp.

Appendix A. Daily Rainfall (mm) during the cropping season at Samaru (1982) [1]

Days of the month	April	May	June	July	Aug.	Sept.	Oct.
1	0.0	0.0	0.0	2.9	0.0	12.2	5.5
2	0.0	0.0	0.0	0.0	0.0	5.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	2.5	0.0	0.0	0.0	0.0
5	0.0	6.2	5.6	0.0	5.5	25.5	0.0
6	0.0	0.0	0.0	24.7	8.8	1.3	0.0
7	0.0	0.0	0.0	0.0	0.0	4.9	0.0
8	0.0	0.0	0.0	2.0	0.6	0.0	0.0
9	0.0	0.0	0.0	21.7	19.0	19.6	40.3
10	2.3	10.5	0.0	0.0	0.0	3.3	0.0
11	0.0	0.0	16.2	19.0	3.5	8.6	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	5.1	8.5	0.0
14	5.5	0.0	0.0	45.1	7.1	0.4	0.0
15	1.2	0.0	0.0	0.0	0.0	0.0	0.0
16	13.3	5.3	28.0	12.4	1.8	0.0	0.0
17	0.0	0.0	0.0	0.0	2.8	0.0	0.0
18	2.2	0.0	0.0	0.0	0.0	0.0	0.0
19	4.6	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	16.8	25.5	0.0	0.0	15.5	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	11.1	0.0	0.0	52.0	8.8	0.0
23	0.0	0.0	0.0	0.0	7.2	0.0	0.0
24	0.0	0.0	9.0	0.0	7.7	0.0	0.0

Appendix A. contd.

25	0.0	0.0	4.7	0.0	2.9	0.0	0.0
26	5.6	0.2	0.0	37.0	2.3	0.0	0.0
27	7.9	0.0	0.0	0.0	0.0	0.0	0.0
28	0.4	0.0	22.4	0.0	5.1	0.0	0.0
29	16.7	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	1.9	26.7	0.0	0.0
31	0.0	22.0	0.0	1.9	0.0	0.0	0.0
Total	59.7	72.1	113.1	168.7	190.7	117.6	45.8

1 Source - Meteorological Unit, IAR, Samaru, Nigeria.

Appendix B. Temperature and sunshines at Samaru and Kadawa during the period January - December, 1982.

Month	Temperature (°C) Max.	Min.	Sunshine Hours/Day
	Samaru		
Jan.	29.5	16.0	8.6
Feb.	30.8	16.5	7.8
Mar.	34.1	17.9	7.6
Apr.	32.8	22.0	8.1
May	32.7	23.5	8.2
June	30.5	25.0	7.3
July	28.9	23.7	6.6
Aug.	26.9	22.9	6.6
Sept.	29.0	23.6	7.1
Oct.	30.0	22.6	8.0
Nov.	29.3	16.7	8.0
Dec.	30.0	15.4	8.4
	Kadawa		
Jan.	26.5	12.2	7.2
Feb.	27.1	14.7	7.6
Mar.	36.2	19.5	7.0
Apr.	37.3	22.7	7.7
May	36.3	23.7	NA
June	32.9	21.2	NA
July	30.9	21.0	NA
Aug.	30.2	20.4	NA
Sept.	31.8	20.9	NA

Appendix B. contd.

Oct.	32.3	16.7	NA
Nov.	32.2	14.2	NA
Dec.	30.3	13.9	NA

1 Source: Meteorological Unit, IAR, Samaru, Nigeria

2 NA = Not available.

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

Common name	Chemical name
Alachlor	2-chloro-2,6-diethyl-N-(methoxymethyl)acetamide.
Chlorbromuron	N-(4-brom•-3-chlorophenyl)-N-methoxy-N-methylurea
Chlorthal-dimethyl	2,3,5,6-tetrachloroterephthalicacid dimethyl ester
Dimethametryn	2,(1,2,dimethylpropylamino)-4-ethylamino-6-methylthio-1,3,5-triazin)
Diphenamid	N,N-dimethyl-2,2-diphenylacetamide
Linuron	3-(3,4-dichlorophenyl)-1-methylurea.
Metobromuron	2-(4-bromophenyl)-1-methoxy-1-methylurea
Metolachlor	2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl).
Oxadiazon	3-(2,4-dichloro-5-isopropoxyphenyl)-5-t-butyl-1,3,4-•xadiazolin-2-•ne
Pendimethalin	N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine

Appendix D. Fitted values for fresh pepper fruit yield (t/ha)

Period (Weeks)	Wet season '82	Dry season 82/83.	
	Samaru	Samaru	Kadawa
0	4.08	2.85	1.75
3	4.69	2.71	2.29
6	6.62	2.71	3.51
9	9.57	3.15	4.88
12	12.58	3.88	5.95
15	14.04	4.32	6.36
0	17.38	4.01	7.51
3	14.18	3.96	6.74
6	8.47	3.63	4.99
9	4.17	2.98	3.03
12	2.68	2.21	1.48
15	2.86	1.81	0.88

Appendix E. Values of regression coefficient for fitted curves on fruit yield.

	Initially weed-free	
Samaru 1982	Samaru 1982/83	Kadawa 1982/83
a 4.08111	2.84699	1.75411
b_2 0.05816	-0.03062	0.07209
b_3 0.00405	0.00583	-0.00414
	Initially weed-infested	
a 17.37930	4.00745	7.50946
b_2 -0.48690	0.00135	0.10251
b_3 0.04771	-0.00279	0.00581

Appendix F. Fitted values of fresh weed weight (t/ha)

Initially Weed-free	Wet season Samaru	Dry season Samaru	Dry season Kadawa
0	62.76	11.32	32.46
3	43.79	9.23	24.91
6	24.82	7.15	17.35
9	5.85	5.07	9.80
12	2.60	2.98	2.24
15	2.60	2.98	1.28

Initially Weed-infested	Wet season Samaru	Dry season Samaru	Dry season Kadawa
3	3.78	1.22	3.58
6	58.59	2.94	11.22
9	58.59	4.67	18.86
12	58.59	6.39	26.51
15	58.59	8.12	34.16

Appendix G. Values of resression coefficient for fitted curves on fresh weed weight.

	Samaru 1982	Samaru 1982/83	Kadawa 1982/83
		Initially weed-free	
a	62.76	11.320	32.46
b	-6.323	-0.695	-2.518
t_1	9.514	12.01	12.38
k	2.60	2.98	1.28
		Initially weed-infested	
a	-51.03	0.51	-4.08
b	+18.27	0.58	2.55
t_1	6.05	15	15
k	59.5	8.12	34

Appendix H-1. Mean square for the analysis of variance of crop vigour score as affected by period of weed interference in pepper at Samaru in 1982 wet season and Samaru and Kadawa in 1982/83 dry season.

		Crop vigour score					
		Wet season 1982		Dry season 1982/83			
		Samaru		Samaru		Kadawa	
Source of variation	D.F.	6 WAT	9 WAT	6 WAT	9 WAT	6 WAT	9 WAT
Replication	3	12.717	7.45	0.866	0.816	8.656	3.073
Treatment	9	5.392**	9.59**	6.544**	3.386**	5.890**	13.140**
Error	27	0.879	1.27	1.653	0.877	0.786	1.629
Total	39						

* F value significant at the 5% level of probability.

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

Appendix H-2. Mean square for the analysis of variance of leaf count as affected by period of weed interference in pepper at Samaru in 1982 wet season and Samaru and Kadawa in 1982/83 dry season

		Leaf count				
		Wet season 1982			Dry season 1982/83	
			Samaru		Samaru	Kadawa
Source of variation	D.F.	6 WAT	9 WAT	12 WAT	9 WAT	15 WAT
Replication	3	4197.75	3567.83	5477.63	1953.83	151832.43
Treatment	9	5841.46	3120.36	12111.56	1607.67	59233.89
Error	27	1908.22	612.68	3022.70	738.27	27330.93
Total	39					

* F value significant at 5% level of probability.

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

Appendix H-3. Mean square for the analysis of variance of number of branches per plant as affected by period of weed-interference in pepper at Samaru in 1982 wet season and Samaru and Kadawa in 1982/83 dry season

Source of variance	D.F.	Number of branches per plant		
		Wet season 1982	Dry season 1982/83	
		Samaru	Samaru	Kadawa
		9 WAT	9 WAT	12 WAT
Replication	3	34.09	32.96	973.20
Treatment	9	40.95**	55.97*	8236.60**
Error	27	7.93	21.35	1350.20
Total	39			

* F value significant at the 5% level of probability.

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

Appendix H-4. Mean square for the analysis of variance of plant height as affected by period of weed-interference in pepper at Samaru in 1982 wet season and Samaru and Kadawa in 1982/83 dry season.

		Plant height		
		Wet season 1982	Dry season 1982/83	
Source of variance	D.F.	Samaru at 9 WAT	Samaru at 12 WAT	Kadawa at 6 WAT
Replication	3	195.123	579.49	0.709
Treatment	9	86.813*	791.45*	24.215
Error	27	27.320	377.27	12.342
Total	39			

* F value significant at the 5% level of probability

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

Appendix H-5. Mean square for the analysis of variance of flower number per plant as affected by period of weed-interference in sweet pepper at Samaru in 1982 wet season and at Samaru and Kadawa in 1982/83 dry season.

Source of variation	D.F.	Flower number per plant		
		Wet season 1982	Dry season 1982/83	
		Samaru at 6 WAT	Samaru at 9 WAT	Kadawa at 6 WAT
Replication	3	0.35	11.76	134.30
Treatment	9	1.79**	51.18*	64.77
Error	27	0.19	20.20	47.19
Total	39			

* F value significant at 5% level of probability.

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

Appendix K-6, Mean square for the analysis of variance of fruit number per plant as affected by period of weed-interference in sweet pepper at Samaru in 1982 wet season and Samaru and Kadawa in 1982/83 dry season

Source of variation	D.F.	Fruit number per plant		
		Wet season 1982 Samaru	Dry season 1982/83 Samaru	Kadawa
Replication	3	89388.87	2838.23	20441304 2
Treatment	9	220776.79**	21686.86**	219686.19**
Error	27	50647.99	3952.35	59872.63
Total	39			

* F value significant at 5% level of probability

** F value significant at 1% level of probability

Appendix H-7. Mean square for the analysis of variance of fruit yield as affected by period of weed-interference in sweet pepper at Samaru in 1982 wet season and Samaru and Kadawa in 1982/83 dry season.

Source of variation	D.F.	Fruit yield		
		Wet season 1982	Dry season 1982/83	
		Samaru	Samaru	Kadawa
Replication	3	6.83	13.00	42.40
Treatment	9	9.04**	28.80*	145.00**
Error	27	1.44	9.37	8.87
Total	39			

* F value significant at 5% level of probability

** F value significant at 1% level of probability

Appendix H-8. Mean square for the analysis of variance of weed weight as affected by period of weed-interference in sweet pepper at Samaru in 1982 wet season and Samaru and Kadawa in 1982/83 dry season.

Source of variation	D.F.	Weed weight		
		Wet season 1982	Dry season 1982/83	
		Samaru	Samaru	Kadawa
Replication	3	6.83	10.50	8.08
Treatment	9	9.04**	19.30*	40.10**
Error	27	1.44	6.43	3.47
Total	39			

* F value significant at 5% level of probability

** F value significant at 1% level of probability

Appendix H-9. Mean square for the analysis of variance of weed score and weed weight as affected by chemical weed control in pepper at Samaru in 1982 wet season.

Source of variation	D.F.	Weed score at 3 WAT	Weed score at 6 WAT	Weed score at 9 WAT	Weed weight at harvest
Replication	3	5.28	7.73	27.61	181.00
Treatment	35	14.07**	4.42**	11.41**	24.60**
Error	102	2.09	1.03	1.56	6.59
Total	140				

* F value significant at 5% level of probability

** F value significant at 1% level of probability

Appendix H-10. Mean square for the analysis of variance of weed score and weed weight as affected by chemical weed control in pepper at Kadawa in 1982/83 dry season.

Source of variation	D.F.	Weed score at 3 WAT	Weed score at 6 WAT	Weed score at 9 WAT	Weed weight at harvest
Replication	3	3.30	5.98	1.02	25.89
Treatment	23	5.20**	4.41**	4.74**	364.34**
Error	69	1.76	0.99	1.08	41.05
Total	95				

* F value significant at 5% level of probability

** F value significant at 1% level of probability

Appendix H-11. Mean square for the analysis of variance of crop growth parameters as affected by chemical weed control in pepper at Samaru in 1982 wet season.

Source of variation	D.F.	Crop vigour score at 9 WAT	Plant height at 4 WAT	crop stand count at harvest	Number of branches/plant at harvest
Replication	3	13.19	6.48	23.21	38.99
Treatment	35	4.17*	25.50*	7.65**	17.46*
Error	102	2.93	18.26	3.67	10.42
Total	140				

* F value significant at 5% level of probability

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

Appendix H-12. Mean square for the analysis of variance of crop growth parameters as affected by chemical weed control in pepper at Kadawa in 1982/83 dry season.

Source of variation	D.F.	Crop vigour score at 6 WAT	Crop vigour score at 9 WAT	Plant height at 5 WAT	Crop stand count at harvest	Number of branches/plant at harvest
Replication	3	1.73	22.86	150.75	128.86	10.33
Treatment	23	3.16**	4.30**	58.21	52.22**	1.31
Error	69	0.81	1.43	88.94	13.98	1.17
Total	95					

* F value significant at 5% level of probability

** F value significant at 1% level of probability

Appendix H-13. Mean square for the analysis of variance of fruit number and yield as affected by chemical weed control in pepper at Samaru in 1982 wet season.

Source of variation	D.F.	Fruit number	Fruit yield
Replication	3	76.70	28.80
Treatment	34	6.20**	1.87**
Error	102	2.27	1.06
Total	140		

* F value significant at 5% level of probability

** F value significant at 1% level of probability

Appendix H-14. Mean square for the analysis of variance of fruit number and yield as affected by chemical weed control in pepper at Kadawa in 1982/83 dry season.

Source of variation	D.F.	Fruit number	Fruit yield
Replication	3	99.40	54.60
Treatment	23	17.00**	7.39**
Error	69	9.35	3.60
Total	95		

* F value significant at the 5% level of probability.

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

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