EFFECTS OF NITROGEN, PERIOD OF WEED INTERFERENCE AND CHEMICAL WEED CONTROL ON OKRA (*Abelmoschus esculentus* (L.) Moench)

BY

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A Dissertation submitted to the Postgraduate School
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degree of Doctor of Philosophy in Agronomy

DEPARTMENT OF AGRONOMY
FACULTY OF AGRICULTURE
AHMADU BELLO UNIVERSITY
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NOVEMBER, 1988

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 in any previous publication for a higher degree.

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DEDICATION

This work is dedicated to my wife, Silifat and our children, 'Femi, 'Tokunbo, Ivabo, 'Tosin and Hakeem for their persevearance and encouragement throughout the period of this study.

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- K.O. Adejonwo (1988)

ABSTRACT

Field experiments were conducted during the 1984 and 1985 dry season at Kadawa in the Sudan savanna and during the wet season at Samaru in the northern Guinea Savanna ecological zones of Nigeria. The aim was to study the effect of nitrogen on the response of two varieties of okra (Abelmoschus esculentus (L.) Moench) to various periods of weed interference and to identify suitable methods including the use of herbicides, for season-long weed control in the crop.

In the weed interference experiment, the two okra varieties, V35 and TAE-38 were similar in growth, yield and in their responses to nitrogen application. Variety of okra had no effect on weed cover and weed dry matter production because of their similar growth pattern. However, periods of weed interference significantly influenced all the variables considered including fruit yield. Keeping the crop weed-free until 3 weeks after sowing (WAS) did not prevent depression in growth and yield of okra due to the adverse effect of subsequent weed infestation. Conversely, weed interference until 3 WAS had no adverse effect on okra plants. Infestation until 6 WAS however depressed the vigour, height, leaf number, shoot dry matter production, fruit number and yield. The crop was most critically affected by weed interference between 3 and 6 WAS, Crop kept weed-free for 12 WAS and longer had fruit yield comparable with that weeded throughout the growth period. In order to obtain maximum yield, it was required to keep the crop weed-free for a period of 12 weeks or more from the time of sowing.

In the herbicide evaluation trials, the two varieties of okra did not differ significantly in growth and yield. However, variety TAB-38 contained higher per cent crude protein but was less viscous than V35. Among the herbicide treatments, metolachlor plus prometryne at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding (at 6 WAS) was the most consistent in all the trials in terms of good weed control and high okra fruit yields that were comparable to three hoe-weedings. Although directed post-emergenee herbicide treatments effectively controlled weeds, they were phytotoxic to okra plant as reflected in depressed crop growth characters and low okra fruit yields. Significant effect of weed control treatments on fruit viscosity and per cent crude protein content was also observed.

In the study, uncontrolled weed growth throughout the crop life-cycle depressed crop vigour, height, leaf number and shoot dry matter production. It also reduced okra fruit yields by 92% and 94% compared with the appropriate best treatments in the weed interference and chemical weed control experiments, respectively.

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Chapter 1

INTRODUCTION

1.1 Okra Production and Economic Importance

Okra (Abelmoschus esculentus (L.) Moench) is a member of the Malvaceae family and it is mainly cultivated for its young fleshy fruits. The total world production was estimated at 4.1 million tonnes out of which developing countries produce about 3.1 million tonnes (Grubben, 1977). Although no production figures are available for Nigeria because most of the produce is consumed locally, a yield range of 6 to 12 t/ha was recorded under local conditions where it is cultivated either alone or in mixture with other crops over a total area of about 1.5 million hectares (Anon., 1980).

In the country, okra is normally produced throughout the year. It is produced in abundance under rainfed condition and on a limited hectarage in the dry season with irrigation or in valley bottoms and river banks using residual moisture for its production. Fresh pod yields could be highly variable depending on the growing season, variety and cultural management practice (Majanbu, 1983).

Okra fruit is used in the preparation of soups and stews because of its mucilaginous property. Eka (1978) observed that mucilaginous property, that is, sliminess or ability to 'draw' is an important determinant of

acceptability of okra cultivar in most African countries. The pod is a good source of vitamins, minerals and protein. It has ascorbic acid content of 203 mg/100g in fresh fruit (Keshinro and Ketiku, 1979) and high levels of calcium, iron, fibre and ash (Oyenuga, 1968; Oyolu, 1983). Savello et al. (1980) reported that okra seeds with the hulls removed contained 33% protein, 26% lipid and 6% ash. Since the seed is high in the amino-acid lysine, the crop is a source of high quality protein and can therefore serve as a supplement to cereal-based diets in which the amino-acid is limiting (Al-wandawi, 1983).

1.2 Climatic and Agronomic Requirements of Okra

Okra is a tropical crop which is susceptible to drought and low night temperatures (Anon., 1983a). It requires day temperatures between 25 °C and 40 °C with night temperature of over 22 °C (Grubben, 1977). An average annual rainfall of 750 mm is adequate for okra growth. For dry season production, the crop is deep-rooted and will not require frequent irrigation provided the soil is saturated with water to field capacity at each application done once or twice a week. The crop can be grown on any type of soil but doest best on well manured loams (Purseglove, 1974).

Research work on local vegetables in Nigeria has received relatively little attention. Until recently, there was virtually no research information on the basic agronomic requirements of the crop. Differential green pod yield response of okra varieties to nitrogen fertilizer has been reported in the forest zone (Fatokun and Chheda, 1983) and northern Guinea savanna of Nigeria (Majanbu et al., 1984). However, most of the reports on the effect of nitrogen application on green pod yield in okra have been conflicting. Fatokun and Chheda (1983) found that okra fresh fruit yield was significantly increased by the first 56 kg N/ha while the crop did not respond significantly to additional 56 kg N/ha.

1.3 Weeds and their Control in Okra

There is paucity of information on the effect of weeds on growth and yield of okra in Nigeria. Yield losses due to unchecked weed growth are very high in vegetable crops because they are very sensitive to competition especially during the early stages of growth (Roberts, 1976). In the northern Guinea savanna zone, unchecked weed growth in okra have been reported to have caused yield losses of 73% (Lagoke et al., 1983) and 79% (Adejonwo et al., 1987) of the potential in the crop. Evaluation of the effect of weed interference and the critical period of weed competition with the crop is essential in order to plan an efficient chemical and/or cultural weed control programme.

Cultural practices could be used to minimize the negative effect of weed-crop competition through the manipulation of the plant architecture, using rapid canopy development by the crop to enhances its competitiveness with weeds. Competitiveness and canopy development are associated with plant height in many crop varieties (Jennings and Jesus, 1968). Therefore, the use of low-growing okra varieties where rapid canopy development provide adequate shade to smother subsequent weed growth would be an advantage in the overall weed management strategy.

The precise and efficient control of weeds among other factors constitute an important agronomic problem in okra production. In Nigeria, hand weeding which is the most common method of controlling weeds in the crop is labour-intensive, expensive and inefficient hence the need for chemical weed control which appears to be a good alternative. The use of herbicides to control weeds in vegetables and field crops has been found to be profitable (Sinha et al., 1982; Bakut, 1985; Ogungbile and Lagoke, 1986). Reported investigations on chemical weed control on okra in Nigeria have suggested pre-emergence application of herbicide mixtures followed by supplementary hoe-weeding later. In irrigated okra, Lagoke et al. (1983) observed that mixtures of metolachlor with terbutryne and alachlor with prometryne, each at 2.0 + 1.0 kg a.i./ha followed by supplementary

hoe-weeding at 6 weeks after sowing (WAS) resulted in pod yields similar to two and three hoe-weedings. Similarly, effective weed control and high okra pod yields were also reported with mixtures of metolachlor with terbutryne at 1.33 + 0.67 kg a.i./ha and alachlor with prometryne at 2.0 + 1.0 kg a.i./ha, each followed by supplementary hoe-weeding at 6 WAS in rainfed maize/okra crops (Adejonwo et al., 1987). In effect, none of the herbicide treatments used by the workers was able to provide season-long weed control in the crop.

1.4 Objectives of the Study

The study was therefore conducted with the following objectives:

i) To study the effect of nitrogen on the response of two varieties of okra to various periods of weed interference, and

ii) to identify suitable methods including herbicide use for season-long weed control in okra and the effects of herbicides on fruit quality.

Chapter 2

LITERATURE REVIEW

2.1 Effect of Variety on Growth and Yield of Okra

At Ibadan in the forest zone of Nigeria, Adelana (1981) observed that 'V35' and 'Jokoso' okra varieties exhibited similar growth pattern at the early stage of growth but attained peak dry matter production at different times at the late stage of growth. Although both varieties gave similar number of flowers and fruits, 'Jokoso' produced higher fruit yield. Fatokun and Chheda (1983), also at Ibadan, reported significantly higher total number of fruits per plant and fruit yield in cultivar 'Pusa Sawani' than 'Ibk-2'.

At Samaru in the northern Guinea savanna zone of Nigeria, Majanbu et al. (1985) tested two varieties of okra and found that 'NHAE 47-4' had significantly higher pod yield and number of green pods per plant than 'white velvet'. Although plants of both varieties attained similar height, variety 'white velvet' attained 50 per cent flowering sooner than 'NHAE 47-4'.

2.2 Effect of Nitrogen on Growth and Yield of Okra

Okra plant growth is greatly retarded when nitrogen supply is deficient (Chhonkar and Singh, 1963; Watanabe and Inayama, 1977). Nitrogen deficiency symptoms in okra include stunted

growth, thin shoot and small yellow leaf production. Under extreme conditions of nitrogen deficiency, premature leaf abscission occurs with consequent production of small, tough and warty pods. Nitrogen fertilizer has been reported to significantly increase plant growth parameters such as plant height, number of leaves and branches per plant and dry matter in okra (Chhonkar and Singh, 1963). In contrast, Chauhan and Gupta (1973) observed lack of response of these paramters to applied nitrogen.

Reports on the effect of nitrogen on flower development in okra have not been consistent. Kamalanathan et al. (1970) found that flowering was delayed by excessive nitrogen supply while Rao (1972) observed that the number of days to flowering in okra is more of a varietal characteristic than environmental. Chauhan and Gupta (1973) and Majanbu (1983) did not also observe any influence of nitrogen on the number of days to flowering.

A major yield component in okra is the number of fruits per plant (Fatokun et al., 1979). Significant increase in the number of fruits per plant as the level of nitrogen was increased has been reported (Asif and Greig, 1972; Fatokun and Chheda, 1983 and Majanbu et al., 1985).

Ahmad and Tullock-Reid (1968) recommended nitrogen level of 112 kg/ha for maximum okra fruit yields. However, Verma et al (1970) observed a decrease in fresh okra fruit yield when nitrogen application was increased to 120 kg/ha.

Randhawa and Pannum (1969) also reported that fruit weight was not significantly affected by nitrogen levels. Majanbu et al. (1985) however observed that nitrogen application at the rate of 100 kg N/ha increased green pod yield of okra by 100% compared with no nitrogen in one of two years of trials. Similarly, in Nepal, Shrestha (1983) reported a lack of response to nitrogen fertilizer in the first year and a quadratic response the following year. In India, linear increases in green pod yield was reported with nitrogen application of between 56 and 135 kg N/ha (Mani and Ramanathan, 1980; Hooda et al., 1980). Majanbu et al. (1985) therefore suggested that the optimum nitrogen requirement of the crop would depend on genetic, climatic and edaphic factors. The lack of response of okra to nitrogen fertilizer in some of these studies may be attributable to differences in native fertility of the soils and weather conditions at the various experimental sites.

2.3 Effect of Weed Interference on Growth and Yield of Okra and Other Vegetable Crop

Interference is the detrimental effects of one plant species on another resulting from their interactions with each other (Akobundu, 1987) while competition is the relationship between two or more plants in which the supply of a growth factor falls below these combined demands (Aldrich,1984;

According to Akobundu (1987), interference therefore includes both competition and amensalism which he defined as the interaction in which growth of one of the organisms (plants) is depressed while the other is unaffected. He further argued that since it is common to measure the depressive effect of weeds on crop yield and ignore the effect of crops on weed growth in weed-crop interactions, such data can only be used to illustrate competition but not amensalism.

Roberts (1976) reported that in the absence of any weed control in vegetable crops, losses in yield ranged from 20 to 100% depending on weed species and growing conditions. In Brazil, William and Warren (1975) observed that yield loss in okra due to purple nutsedge competition during the entire cropping season was 62%. In India, Singh et al. (1981) reported 80% loss in okra seed yield in unweeded plots compared to weed-free plots.

At Samaru, Nigeria, Adigun et al. (1982) reported that weed infestation significantly depressed various growth parameters in pepper such as crop vigour, leaf, branch and fruit number and reduced yield by 80% compared with crop kept weed-free throughout its life-cycle. Lagoke et al. (1988), also at Samaru, reported 87% loss in chilli pepper fruit yield as a result of weed competition throughout its growth period.

2.4 Critical Period of Weed Interference in Okra

The most susceptible period of crop growth to weed interference has been described as the critical period of weed interference (Nieto et al., 1968). For most crops, weed competition during the first quarter of the growth period was observed by these workers to be very critical because the damage to crop at this stage is irreparable. Conversely, if such damage could be avoided during this early period, subsequent weed growth is unlikely to have significant effect on yield. The studies of Kasasian and Seeyave (1969) on the critical period of weed competition in a number of vegetable crops showed that the first third of a crop life-cycle has to be maintained free of weed competition if adverse effect on yield is to be avoided.

Factors such as the relative growth of the crop and weeds. Density of planting, variety grown and time of moisture and nutrient stress have been reported by Shadbolt and Holm (1956) to influence the precise time and duration of maximum competition.

In Brazil, the critical period of weed competition with okra occurred between 3 and 7 weeks after sowing (William and Warren, 1975). However, in India, Singh et al. (1981) observed that the most critical period of weed competition with okra was 2 to 6 weeks after sowing.

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2.5 Effect of Seasonal Variation on Growth and Yield of Okra

Seasonal differences have been found to affect growth and yield of okra in several parts of the world. Fatokun and Chheda (1983) reported that yields of okra planted early (April) were higher than the late crop (August). The significant variation in response of okra to fertilization reported by Majanbu et al. (1985) was attributed to the better weather conditions that prevailed during one of the seasons. In India, Bisaria and Shamshery (1979) reported highest okra pod yield in the rainy season (July to September) compared with those in the winter (October to January) and summer (March to June) seasons. It appears that early planting and favourable rainfall (in quantity and distribution) favour okra growth particularly the number of fruits produced per plant .

2.6 Interaction between Variety and Nitrogen in Okra

Studies on the growth of two cultivars of okra and the effect of rate of nitrogen application on them in the forest zone of Nigeria have shown that nitrogen increased number of fruits per plant and fruit yield although the magnitude tended to be greater in cultivar 'Pusa sawani' than in 'Ibk-2' (Fatokun and Chheda, 1983), It was further observed that application of nitrogen at 112 kg/ha increased the fruit

yields of cultivar 'Pusa sawani' from 13.09 t/ha to 16.59 t/ha while the corresponding yield of cultivar 'Ibk-2' was from 11.60 t/ha to 14.73 t/ha, compared with no nitrogen treatment.

In the northern Guinea savanna of Nigeria, Majanbu et al. (1985) however, reported that the two varieties of okra used responded to nitrogen application differentially with respect to yield and yield-related characters such as the number of pods per plant and pod diameter. They found that when the two varieties were considered at different rates of nitrogen ranging from 0 to 100 kg N/ha, variety 'NHAE 47-4' had significantly higher values for all these parameters than var. 'white velvet'.

2.7 Chemical Weed Control in Okra

Herbicides that have either been evaluated singly or in mixture with others for selective weed control in okra included metolachlor (2-chloro-N-(2-ethyl-6-methylphenyl)-N- methoxy-1-methyl) acetamide, alachlor (2-chloro-2,6-diethyl-N-(methoxymethyl) acetanilide), terbutryne (2-Ttert-butylamino-4-(ethylamino)-6-methylthio-5-triazine), prometryne (4,6-bio-isoprophyl amino-2-methlthio-1,3,5-triazine), diphenamid (N,N-dimethyl-2,2-diphenyl acetamide), and pendimethalin (N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamide). The relative solubility of these herbicides and their LD_{50} are listed in appendix 1. The herbicides have been evaluated in okra and observed to show

good performance both in terms of weed control and crop selectivity (Wascom and Fontenot, 1967; Bazan, 1976; Jackson, 1976; Chew et al., 1977; Lee, 1978; Randhawa and Sandhu, 1978; Rajagopal and Ashok-Metha, 1979; Brathwaite, 1981; Lagoke et al., 1983; Lagoke et al., 1987; Adejonwo et al., 1987).

2.7.1 Triazines

The triazines are heterocyclic nitrogen derivatives. The heterocyclic ring is composed of three nitrogen and three carbon atoms (Klingman and Ashton, 1975). Triazine herbicides are symmetrical or assymetrical depending on whether the three nitrogen atoms in the heterocyclic benzene ring of their chemical structure are symmetrically arranged or lack that symmetry. The s-triazines are divided into three sub-groups that consist of the chloro-diamino-, methoxy diamino- and methylthio-diamino-s-triazines and these have common names that end with - zine, -tone and - tryne, respectively (Akobundu, 1987). While uptake of all herbicides in this group is mainly through plant roots, foliar uptake occurs with the more soluble methylthio - diamino-s-triazines such as prometryne and terbutryne (Kearney and Kaufman, 1975). Absorption of triazine herbicides is usually by roots and translocation takes place through the apoplastic system to the shoots of plants (Gleen et al., 1975).

Triazine herbicides are well known inhibitors of photosynthesis in plants. The site of action is the chloroplast and the mechanism of this inhibition involves the blocking of the Hill reaction associated with photosystem II (Moreland, 1967).

The triazines are the most widely used herbicides in food crop production in the tropics (Akobundu, 1987). They control seedling grasses and broadleaves. The usual phytotoxic symptom of the triazine herbicides is foliar chlorosis followed by necrosis. However, the first effect is the reduction of the amount of glucose, fructose and/or sucrose in plants (Audus, 1976). Very low concentrations of the herbicide in the leaves cause increased greening due to increase in chlorophyll content of the leaves while high concentrations cause chlorosis and necrosis. Selectivity of these herbicides is due mainly to differential rate of metabolism in plants (Jachetta and Radosevich, 1981). Resistant species metabolize the herbicides at a faster rate than susceptible species. This process occurs by hydroxylation, dechlorination, demethoxylation or demethylthiolation depending on the parent substitution. Dealkylation of the alkyl side chains also occur (Kearney and Kaufman, 1975).

2.7.1.1 Prometryne

The methyl thio-diamino-s-triazines to which prometryne and terbutryne belong have good post-emergence activity and crop tolerance with relatively short residual life. Members of this group are compatible with several herbicides (Akobundu, 1987).

Reports have shown that prometryne is being used alone or in mixture with other herbicides for the selective control of broadleaved weeds and some grasses in various crops such as cotton, groundnut, soyabean, okra, yam and potato in the Nigerian savanna (Lagoke et al., 1983; 1986a; 1986b; Bulus, 1986; Adejonwo et al., 1987). It is also used post-emergence mainly as directed spray because of its contact activity and resists removal from the foliage by rain because of its rapid penetration of the foliage.

Rajagopal and Ashok-Metha (1979) reported that although prometryne at 0.5 kg/ha applied pre-emergence and supplemented with one hand-weeding at 30 DAS resulted in the highest fruit yield compared with the hand-weeded control, its application at the rate of 1.0 kg/ha in okra was the most effective and economical treatment. Brathwaite (1981) observed that pre-emergence application of prometryne at 2.0 kg/ha maintained good weed control 42 days after treatment and produced the highest fruit yield although slight initial injury to plants was caused by the herbicide. Pre- emergence

application of prometryne plus metolachlor at 1.5 + 1.5 kg a.i./ha has been found to give effective weed control and good tolerance with consequent high yield of okra fruits (Adejonwo et al., 1987).

2.7.1.2 Terbutryne

Terbutryne may be applied either pre-emergence or post-emergence at rates of 1.0 to 2.0 kg a.i./ha for the selective control of broadleaved weeds in wheat, barley, sorghum, groundnut, soyabean, okra, cotton and a variety of vegetables (Martin and Worthing, 1977; Anon., 1983; Lagoke et al., 1983; Adejonwo et al., 1987). Lagoke et al. (1983) reported that metolachlor plus terbutryne at 1.33 + 0.67 and 2.0 + 1.0 kg a.i./ha resulted in similar okra yields to two or three hoe-weedings. In a mixed maize/okra herbicide evaluation trial, pre-emergence application of terbutryne plus metolachlor at 0.67 + 1.33 kg a.i./ha resulted in higher okra yield than hoe-weeding (Adejonwo et al., 1987).

2.7.2 Amides

The only structural property that all members have in common is that they are all substituted acid amides. All the members are derived from reactions in which the hydroxyl portion of a carboxyl group of an acid has been replaced by an amino group ($-NH_2$). Acid amide herbicides take the name of acid represented by the R group. Thus depending on the

acid group, the herbicide could be an acetamide, propionamide, benzamide, etc. If one of the hydrogens of the ammonium group is replaced by a phenyl group, the resultant herbicide is known as an analide (Akobundu, 1987).

A major subdivision of the amide class of herbicides is the chloroacetamides. They have a monochlorinated methyl ($Cl-CH_2$) in the R-1 position and include metolachlor and alachlor. The chemical structure of the remaining amide herbicides have little in common except for the central amide structure although most have a hydrogen substitution in the R-3 position (Ashton and Crafts, 1981). There is indication that an alpha-chlorine must be present and that the two hydrogen atoms attached to the nitrogen in the acetamide structure must be replaced in order to obtain herbicidal activity (Hamm, 1974). They are mostly used as selective herbicides in vegetable and field crops for the control of grasses although they have activities on broadleaved weeds and sedges (Ashton and Crafts, 1981).

Chloroacetamides are readily absorbed by plants primarily by seeds and first node of germinating seedling and appear to be translocated in the apoplast but symplastic movement may also occur. These herbicides are readily taken up by susceptible and resistant species but appear to be more rapidly degraded in resistant species (Jaworski, 1975). The degree of susceptibility of various weeds to

chloroacetamides could be directly related to the length of time required to initiate the metabolism of these chemicals. Those species that are able to metabolize the chemical as soon as it is absorbed or within a short time thereafter have only small amount of the chemical present internally at any time. On the other hand, those species with delayed or slow metabolic capabilities accumulate relatively higher and therefore lethal concentrations. The basis for selectivity of the chloroacetamide herbicides could therefore be attributed to the ability of resistant plants to metabolize them at a rate sufficient to keep cellular levels below that required for growth inhibition in the leaves (Kearney and Kaufman, 1975). They inhibit mitochondrial phosphorylation and reduce cell division in primary meristems (Audus, 1976). They influence nitrogen metabolism due to the influence they have on nucleic acid and/or protein metabolism. Foliage applied amide damage takes the form of localized or general necrosis, depending on the dose applied while the soil-applied amides inhibit root elongation (Audus, 1976).

2.7.2.1 Metolachlor

Thibodeaux et al. (1977) reported selective weed control in okra with metolachlor at 1.68 to 2.24 kg/ha. A broader spectrum of weed control to include broadleaved

species is possible if metolachlor is combined with other herbicides. In a herbicide mixture evaluation trial in irrigated okra in the northern Guinea savanna of Nigeria, metolachlor plus prometryne at 1.0 + 1.0 kg a.i./ha, metolachlor plus diuron at 1.0 + 0.8 and metolachlor plus linuron at 2.0 + 1.0 kg a.i./ha gave good weed control and resulted in okra pod yields that were comparable to two and three hoe-weedings (Lagoke et al., 1983). In an experiment conducted at Samaru to evaluate the selectivity of herbicides in a mixture of maize and okra, mixtures of metolachlor with terbutryne, metobromuron, fluometuron and chlorbromuron, each at 1.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding and metolachlor plus prometryne at 1.5 + 1.5 kg a.i./ha resulted in effective weed control and good crop tolerance with consequent high yields of both maize and okra (Adejonwo et al., 1987).

2.7.2.2 Alachlor

Lee (1978) studied symptoms of damage and phytotoxicity of herbicides in several vegetables including okra and concluded that alachlor was one of the relatively less toxic herbicides. Putnam and Rice (1979) believed that alachlor injury was caused by shoot uptake of herbicide when rainfall or irrigation occurred within 5 days after sowing. They concluded that environmental conditions most conducive to injury appear to be wet, cool weather. However,

rapidly in tomato seedlings (Hoagland et al., 1974). Its activity is reduced in areas of high rainfall because of leaching problems, but soil incorporation improves efficacy in areas of low rainfall. Wascom and Fontenot (1967) observed that okra yields over a 7 week period showed no significant increase compared to the hoe-weeded control when diphenamid was applied at 6.72 kg/ha. In contrast, Jackson (1976) reported a reduction in okra fruit yield when diphenamid was applied at 5.6 kg/ha. However, diphenamid applied pre-emergence at 2.0 kg.ha gave excellent weed control during the first 28 days resulting in increase in fruit yield inspite of initial slight injury observed in okra plants (Brathwaite, 1981). Soil characteristics such as texture and adsorption to soil colloids might have been responsible for such differences in okra response to soil acting herbicide like diphenamid.

2.7.3 Dinitroanalines

Many members of this group are soil-acting herbicides with little or no foliar activity. Oryzalin and pendimethalin are two members of this group that are less volatile and can be applied pre-emergence without soil incorporation (Akobundu, 1987). Although, the dinitroaniline herbicides are selective pre-emergence herbicides that prevent weeds from emerging through the soil, they are not germination inhibitors as is

the case with the carbamate or acetamide herbicides also applied pre-emergence to weeds. Rather, they kill weed seedlings through inhibition of the development of lateral roots in susceptible plants (Ashton and Crafts, 1981). Other characteristics of the dinitroanilines are stunting of the above-ground parts of susceptible plants, development of dark green colour, swelling and brittleness of the stem or the hypocotyl of seedlings (Parka and Soper, 1977).

As a group, dinitroanilines are very effective in the control of itchgrass (Rottboelia cochinchinesis (Louv.) Clayton). The mode of action of these herbicides is not well understood but there is indication that they inhibit photosynthesis, oxidative phosphorylation, protein, nucleic acid and lipid synthesis (Ashton and Crafts, 1981). The dinitroanilines degrade readily in the soil through the action of micro-organisms (Zimdahl and Gwynn, 1977).

2.7.3.1 Pendimethalin

Pendimethalin is the only member of the dinitroaniline herbicides that is herbicidally active when used as a pre-plant incorporated, pre-emergence or post-emergence herbicide (Akobundu, 1987). It is applied as a pre-emergence treatment for selective control of annual grasses in horticultural crops such as onion, tomato (Anon., 1983),

okra (Lagoke et al., 1983) and pepper (Adigun et al., 1967). In a trial on chemical weed control in okra at Samaru, pre-emergence application of mixture of pendimethalin with prometryne and terbutryne, each at 2.0 + 1.0 kg a.i./ha resulted in poor weed control and low okra pod yields compared with the hoe-weeded control. Similar results to the above were also obtained at Kadawa during 1983 wet season (Lagoke et al., 1984)

2.8 Interaction between Variety and Weed Control Treatments

There is a paucity of research information on the interactive effect of variety and herbicide treatments on growth and yield of okra. However, work done in this area in other crops should be of benefit in the present study.

The effectiveness of herbicide treatments in crops is based on interspecific selectivity or differential response to herbicides among crop and weed species. There are also many instances of intraspecific selectivity to herbicides within species. These differential responses within a species may result in poor weed control or in injury to the crop (Wax et al., 1974).

Differential response to herbicides have been reported among cultivars in maize (Andersen, 1964; Eastin, 1971), soyabean (Burnside, 1972) and cowpea (Akobundu, 1985). Osgood et al. (1972) observed that differences in diuron phytotoxicity between two cultivars of sugarcane were due to differences in the distribution and degradation of diuron. They further reported that other factors known to influence differential response to herbicides among cultivars of crops are environmental conditions such as rainfall, organic matter and cation exchange capacity of the soil.

2.9 Correlation Studies in Okra and Other Vegetable Crops

Singh et al. (1976) and Roy and Chhonkar (1976) reported that okra fruit yield was significantly and positively correlated with plant height, number of branches and leaves per plant and fruit number. Majanbu (1983) also established significant and positive correlation between fruit yield, plant height and number of fruits per plant in okra.

Significant negative correlation were observed between weed infestation, weed weight and yields of various crops including pepper (Adigun, 1984) and potato (Bulus, 1986).

Chapter 3

MATERIALS AND METHODS

3.1 Description of Experimental Sites

Field experiments were conducted at the Irrigation Research sub-station of the Institute for Agricultural Research, Kadawa (11° 39'N, 08°02'E and 500 m above sea level) in the Sudan Savanna ecological zone of Nigeria during the 1984 and 1985 dry seasons (February to May) and at the College of Agriculture Farm, Samaru (11°11'N, 07°38'E and 686m above sea level) in the northern Guinea savanna zone during the 1984 and 1985 wet seasons (June to September).

The fields used at Kadawa were cropped with groundnut and maize in 1983 and 1984 wet seasons, respectively, while the sites used at Samaru were cropped with maize and sorghum in 1984 and 1985 wet seasons respectively. The soils of the experimental sites were sandy loam. Details of their physico-chemical characteristics are contained in Table 1. The meteorological records during the periods of experimentation are also presented in Figures 1 and 2. The common weed species observed on the sites are grasses, broadleaved and sedges (Table 2).

Table 1 Physical and chemical analyses of soil samples taken at two depths from experimental sites.

Soil Properties	Kadawa				Samaru			
	1984		1985		1984		1985	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Physical Properties								
Sand (%)	62	66	68	62	60	64	58	58
Silt(%)	28	24	14	28	14	24	34	28
Clay(%)	10	10	18	10	16	12	8	14
Textural class	Sandy Loam		Sandy Loam		Sandy Loam		Sandy Loam	
Chemical properties								
pH in water	6.50	6.20	6.10	5.90	4.60	4.70	4.70	4.50
pH in 0.01M KCl	5.80	5.60	5.30	5.20	3.90	3.80	4.10	3.90
Organic carbon (%)	0.50	0.20	0.52	0.38	0.10	0.10	0.30	0.30
Total nitrogen (%)	0.02	0.04	0.04	0.04	0.01	0.01	0.03	0.03
Available P (ppm)	30.8	14.0	20.30	10.0	7.70	2.45	2.45	4.90
Exchangeable cations (meq/100g soil)								
K	0.30	0.24	0.24	0.23	0.07	0.07	0.10	0.13
Mg	1.03	0.58	1.11	0.95	0.34	0.39	0.29	0.58
Ca	7.85	6.35	5.99	5.43	1.18	1.22	2.25	3.00
Na	0.41	0.24	0.22	0.26	0.10	0.08	0.05	0.09
C.E.C.	10.60	8.80	9.20	7.40	2.50	2.80	4.00	4.60

Table 2 Weed species at the experimental sites and their levels of infestation

Types of weeds	Plant Family	Level of infestation			
		Kadawa		Samaru	
		1984	1985	1984	1985
Grass Weeds					
Cynodon dacytlon (L) Pers.	POACEAE	M	-	L	M
Dacyloctenium aegyptium(L)P. Beauv	"	M	L	-	L
Digitaria horizontalis Willd	"	H	H	H	M
Eleusine indica(L) Gaertn	"	H	H	H	H
Broad-leaved weeds					
Acanthospermum hispidum D.C.	ASTERACEAE	M	H	H	H
Ageratum conyzoides (L)	ASTERACEAE	H	H	H	M
Amaranthus spinosus (L)	AMARANTHACEAE	M	M	M	H
Amaranthus viridis (L)	AMARANTHACEAE	-	M	M	L
Aspilia africana (Pers.)C.D. Adams	ASTERACEAE	-	-	L	H
Cassia mimosoides (L)	CAESALPINIACEAE	-	-	L	-
Commelina benghalensis (L)	COMMELINACEAE	H	H	H	M
Crotolaria retusa (L)	FABACEAE	-	-	M	M
Ipomoea eriocarpa R. Br	CONVOLVULACEAE	L	-	L	L
Synedrella nodiflora Gaertn.	ASTERACEAE	-	-	L	L
Tridax procumbens (L)	ASTERACEAE	-	-	-	M
Vernonia galamensis (Cass.) Less.	ASTERACEAE	M	-	M	H
Sedge weeds					
Cyperus esculentus (L)	CYPERACEAE	M	H	L	-
Cyperus rotundus (L)	CYPERACEAE	M	H	L	-
Kyllinga squamulata Thonn. ex Vahl.	CYPERACEAE	-	-	L	-

H = high infestation (60-90% frequency of occurrence)

M = moderate infestation (40-59% frequency of occurrence)

L = low infestation (10-39% frequency of occurrence)

- = nil (absent)

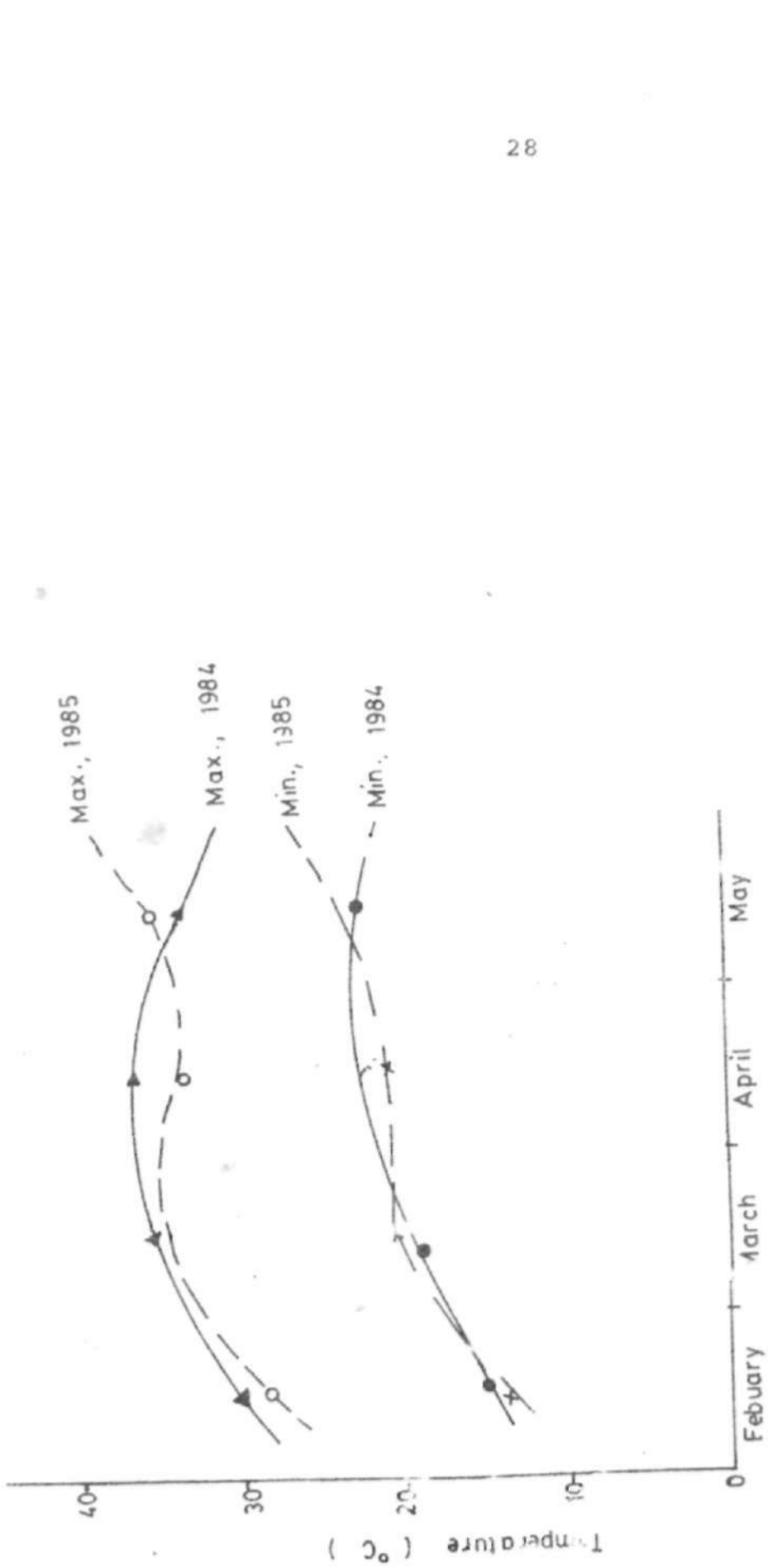


Fig. 2: Mean monthly air temperatures (maximum and minimum) at Kadawa during the 1984 and 1985 dry seasons.

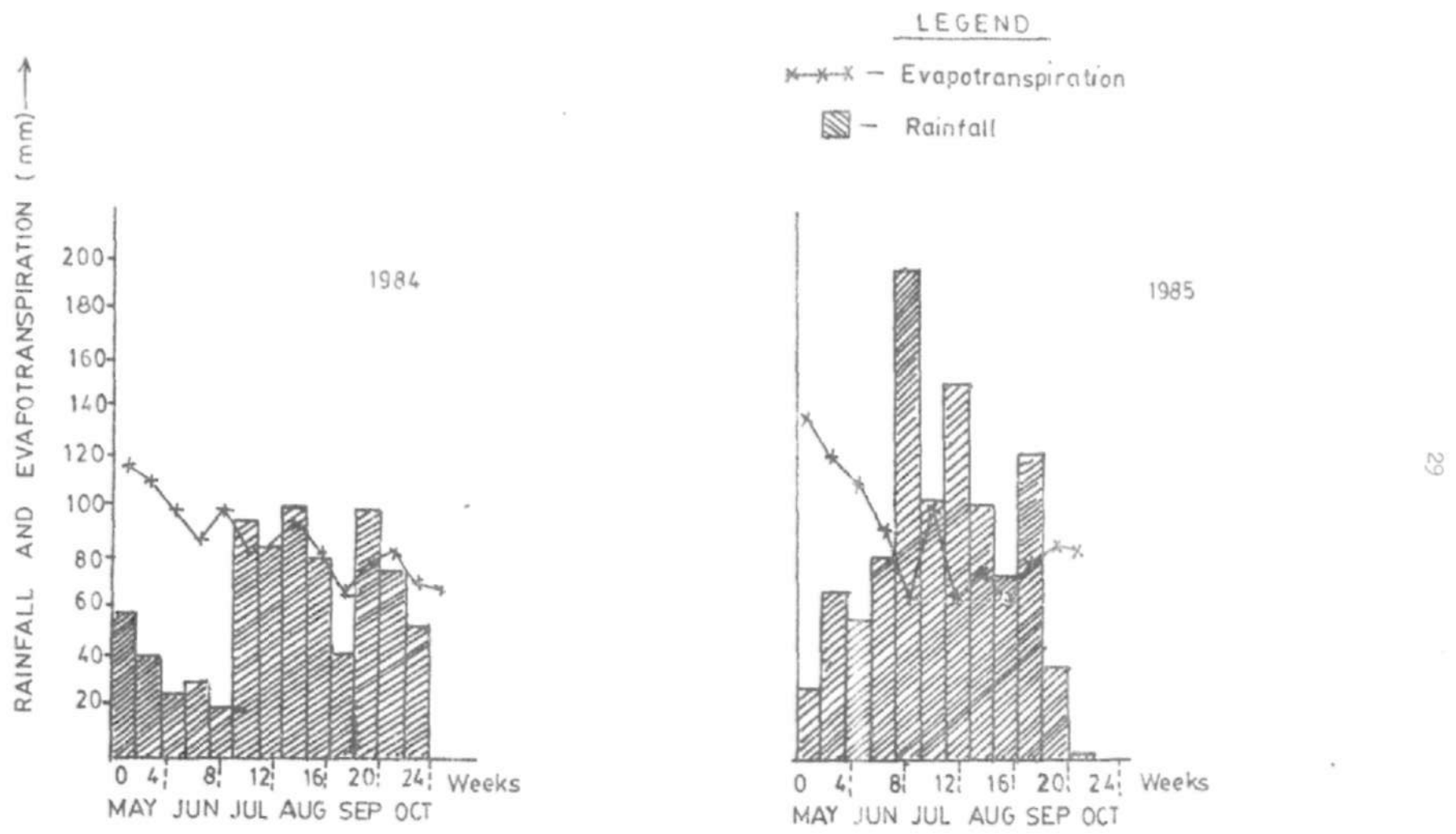


FIG. 1 Mean forthnightly rainfall and evapotranspiration for Samaru (1984 and 1985 wet seasons)

3.2 Cultural Practices

3.2.1 Land preparation and fertilizer application

The experimental fields were ploughed and then harrowed two weeks later. Soil samples were taken from two depths (0-15 cm and 15-30 cm) prior to fertilizer application and analysed for their physico-chemical properties (Table 1). Single superphosphate and muriate of potash were applied as basal dressing to supply 30 kg P_2O_5/ha and 40 kg K_2O/ha respectively before ridges were constructed at 75 cm apart. Nitrogen was applied in the form of calcium ammonium nitrate. Each rate of nitrogen was applied in two equal split doses, at 3 and 6 weeks after sowing. The application was by side-dressing in grooves along the ridges about 7 cm away from the plants and covered with soil.

3.2.2 Varietal characteristics

The two improved varieties used in this investigation, V35 and TAE-38, which were developed by the National Horticultural Research Institute (NIHORT), Ibadan, have similar growth habit, but differ morphologically. They are non-branching, dwarf and slightly hairy stems with a maximum height of 96 cm, compared with local varieties which can be as tall as 180 cm or more. While variety V35 has large alternate cordate leaves with three or five smooth-edged lobes, TAE-38 has leaves with notched or serrated margins. The two

varieties produce bright yellow flowers which are carried singly in the leaf axils on peduncles rarely more than 3cm in length. They are early maturing taking between 48 and 50 days from sowing to fruit formation. In addition, while variety V35 has short pods, TAE-38 produces elongated slender pods which are both hairy and ridged.

3.2.3 Sowing and spacing

The experiments at Kadawa were conducted under irrigation in the dry season from February to May and at Samaru in the wet season between June and September in 1984 and 1985. Three okra seeds of each variety were sown per hill at intra-row spacing of 45 cm on 8/2/84 and 15/2/85 at Kadawa and on 22/6/84 and 17/6/85 at Samaru. The crop was thinned to one plant per stand three weeks after sowing.

3.2.4 Irrigation schedule

The experiment conducted during the dry seasons at Kadawa were irrigated twice per week from the time of planting until the final harvest. The soil was saturated with water to field capacity at each application.

3.3 Treatments and Experimental Designs

The weed interference and weed control experiments were laid out in a split-plot and randomized complete block designs respectively, each with three replicates. The gross and net plot sizes in both experiments were 3.0 m x 4.5m (13.5 m^2) and 1.5 m x 4.5m (6.75 m^2), respectively.

In the weed interference trials, the main plot treatments consisted of two varieties of okra (V35 and TAE-38) and three nitrogen levels (0, 75 and 150 kg/ha) in factorial combinations while the sub-treatments were made up of ten periods of weed interference (Table 3). In the first set of treatments, plots were kept weed-free for 3, 6, 9 and 12 weeks after sowing (WAS). In the second set of treatments, crops were weed-infested initially for the corresponding periods stated above. Two control treatments in which the plots were kept weed free and weed-infested until harvest were also included for comparison.

In the weed control experiments, the sixteen herbicide treatments compared with hoe-weeded and untreated (unweeded) controls at Kadawa during 1984 dry season were eight terbutryne-based and eight prometryne-based mixtures (Table 4). In the subsequent trials, only the promising treatments consisting of mixtures of metolachlor and pendimethalin with terbutryne and prometryne were evaluated. These mixtures were applied either once, pre-emergence or split-applied as

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as pre-emergence and directed post-emergence application between crop rows at 3 WAS. Supplementary hoe-weeding of the pre-emergence treatment at 6 WAS was also included (Table 5).

3.4 Herbicide Application

Pre-emergence herbicide treatments were applied a day after sowing while the directed post-emergence treatments were applied at 3 WAS. The herbicides were applied with CP3 Knapsack sprayer using a deflector nozzle in about 250 l/ha spray volume at a pressure of 2.1 kg/cm².

3.5 Crop Protection

Weeding operations were carried out with hand-hoe according to the treatments. The crop was sprayed against flea beetles damage at 3 and 6 WAS with Cypermethrin at the rate of 0.25 kg a.i./ha using Cymbush 10 EC.

3.6 Observation and Data Collection

3.6.1 Weed infestation

3.6.1.1 Weed cover score

In both the weed interference and weed control experiments, plots were scored for weed infestation using a scale of 0-10, at 6, 9, 12 WAS and at harvest. Zero was given to plots without weeds and 10 to plots with complete weed cover.

Table 3 Details of treatments for the weed interference study in okra at Kadawa and Samaru in 1984 and 1985 dry and wet seasons.

Treatments	Code
Variety	
V35	
TAE-38	
Nitrogen (kg/ha)	
0	
75	
150	
Period of Weed Interference	
Weed-free for 3 WAS[1]	+
Weed-free for 6 WAS	+
Weed-free for 9 WAS	+
Weed-free for 12 WAS	+
Weed-free until final harvest	+
Weed-infested for 3 WAS	++
Weed-infested for 6 WAS	++
Weed-infested for 9 WAS	++
Weed-infested for 12 WAS	++
Weed-infested until final harvest	++

[1] WAS = weeks after sowing

\+ Plot kept weed-free for various periods and subsequently allowed to be infested by weeds until harvest.

++Plot allowed to be weed-infested for various periods and subsequently kept weed-free until harvest.

Table 4 Details of herbicide mixture treatments for the weed control trial in okra at Kadawa, 1984 dry season.

Treatments	
Variety	
V35	
TAE-38	
Weed Control[+]	Rate (kg a.i./ha)
Metolachlor+terbutryne	1.0+0.5
Metolachlor+terbutryne	2.0+1.0
Metolachlor+prometryne	1.0+0.5
Metolachlor+prometryne	2.0+1.0
Diphenamid+terbutryne	1.0+0.5
Diphenamid+terbutryne	2.0+1.0
Diphenamid+prometryne	1.0+0.5
Diphenamid+prometryne	2.0+1.0
Pendimethalin+terbutryne	1.0+0.5
Pendimethalin+terbutryne	2.0+1.0
Pendimethalin+prometryne	1.0+0.5
Pendimethalin+prometryne	2.0+1.0
Alachlor+terbutryne	1.0+0.5
Alachlor+terbutryne	2.0+1.0
Alachlor+prometryne	1.0+0.5
Alachlor+prometryne	2.0+1.0
Weeded check at 3, 6 & 9 WAS[1]	-
Untreated control	-

+ All the herbicide treated plots were supplementarily weeded at 6 WAS.

[1] WAS = weeks after sowing.

Table 5 Details of herbicide mixture treatments for the weed control trials in okra at Kadawa, 1985 dry season and Samaru, 1984 and 1985 wet seasons.

Treatments	
Variety	
V36	
TAE-38	
Weed Control	Rate (kg a.i./ha)
Metolachlor+terbutryne	2.0+1.0
"	2.0+1.0fb[1] 1.0+0.5
"	2.0+1.0fb SHW[2]
"	1.0+0.5fb 1.0+0.5
Metolachlor+prometryne	2.0+1.0
"	2.0+1.0fb 1.0+0.5
"	2.0+1.0fb SHW
"	1.0+0.5fb 1.0+0.5
Pendimethalin+terbutryne	2.0+1.0
"	2.0+1.0fb 1.0+0.5
"	2.0+1.0fb SHW
"	1.0+0.5fb 1.0+0.5
Pendimethalin+prometryne	2.0+1.0
"	2.0+1.0fb 1.0+0.5
"	2.0+1.0fb SHW
"	1.0+0.5fb 1.0+0.5
Weeded check at 3, 6 & 9 WAS[3]	-
Untreated control	-

1 fb = followed by post-emergence herbicide application at 3 WAS

2 SHW= supplementary hoe-weeding at 6 WAS

3 WAS= weeks after sowing

3.6.1.2 Weed dry matter production

Weed dry matter was obtained by taking weed samples from 0.75 m^2 quadrat per plot before weeding the appropriate plots at the specified time and at final harvest (Tables 3, 4 and 5). The weeds were separated into grasses, broadleaved and sedges and oven-dried at 70 °C to constant weight. Cummulative weed dry matter production per plot in the weed interference experiment was determined by adding up all the weed dry weight at each weeding and at harvest.

3.6.2 Crop growth parameters

3.6.2.1 Crop stand count

Crop stand count was taken at 2 WAS and at harvest in order to assess the effect of treatment on the crop establishment.

3.6.2.2 Crop vigour score

Crop vigour score was taken at 6, 9 and 12 WAS using a scale of 0 to 10, where 0 was scored for a plot with completely dead plants and 10 for a plot with very vigorous plants. Parameters taken into consideration in vigour score included plant height, greenness of foliage and the spread of the plant canopy.

3.6.2.3 Crop dry matter production

Using systematic random sampling, four plants per plot were cut at the ground level and oven-dried at 70 °C to constant weight for the determination of dry matter production.

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26.7°C. A factor of 400 which was determined from the manufacturer's chart was used to multiply the viscometer reading in order to arrive at the measurements in centipoise (Brookfield Engineering Laboratories, 1961).

The standard Association of Vitamin Chemists (1966) method was used to estimate ascorbic acid. Fruit samples were oven-dried at 70°C to constant weight before grinding with a mill for nutrient analysis. Crude protein (N x 6.25) was estimated by the micro-Kjeldah method. Values for soluble carbohydrate and ash were determined by official AOAC (1980) methods.

3.9 Analysis of Data

Data collected were subjected to analysis of variance to test the treatment effects for significance using the 'F' test as described by Snedecor and Cochran (1967). Significance of mean differences were tested using Duncan's Multiple Range Test (Duncan, 1955). Correlation and regression analysis were also carried out to determine the association and relationship between the fruit yield and plant characters.

Curves of predicted values of okra fruit yield for varieties V35 and TAE-38 as related to periods of weed interference were obtained using the equation:

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

where Y = yield and Z_2 and Z_3 are functions of time of weeding chosen such that the slope is zero at t = 0 (time of sowing) and t = 15 (time of final harvest) and a, b_2 and b_3 are regression coefficients. The reconstituted equation in quartic form is:

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

The equation gives a sigmoid relationship between yield and weeding time which has a zero slope at both t = 0 and t = 15 weeks, thus depicting the asymptotic relationship.

Chapter 4

RESULTS

4.1 Effects of Variety, Nitrogen and Period of Weed Interference on the Growth and Yield of Okra

The effects of variety, nitrogen and period of weed interference on various growth parameters of okra viz crop height, shoot dry matter production, number of days to flowering, number and yield of fruits are presented in Tables 6 to 34.

4.1.1 Crop vigour score

Varieties of okra did not differ significantly in crop vigour scores at 6, 9 and 12 WAS in all the experiments (Tables 6, 7 and 8). The effect of nitrogen level was only significant at Kadawa in 1985 dry season when crop vigour score at 12 WAS increased with nitrogen level.

In all the trails, period of weed interference significantly affected crop vigour scores. Weed infestation for 6 WAS and longer depressed crop vigour. At Kadawa in both years, crop kept weed-free for 3 WAS only had lower vigour scores than those weed-infested for the same period. In 1985 dry season, crop kept weed free until 6 WAS had lower vigour score than those weed-infested for 3 WAS. In the same year at 12 WAS, crop on plots kept weed-free until 9 WAS had lower vigour than those of the plot infested until 3 WAS. Vigour of okra crop reduced as the weed-infestation

Table 6 Effects of variety, nitrogen and period of weed interference on vigour scores of okra at Kadawa in 1984 dry season.

Treatments	Crop vigour score[1] at		
	6 WAS[2]	9 WAS	12 WAS
Variety (V)			
V35	4.75	4.79	4.51
TAE-38	4.83	5.06	4.66
SE (±)	0.199	0.208	0.202
	NS	NS	NS
Nitrogen (kg/ha) (N)			
0	4.59	4.60	4.28
75	5.05	5.32	4.92
150	4.73	4.85	4.55
S &E(±)	0.244	0.254	0.247
	NS	NS	NS
Period of weed interference (P)			
Weed-free for 3 WAS	2.38bc[3]	1.72c	1.36c
Weed-free for 6 WAS	7.26a	7.06a	6.37a
Weed-free for 9 WAS	-[4]	7.38a	7.09a
Weed-free for 12 WAS	-	-	7.31a
Weed-free until harvest	-	-	-
Weed-infested for 3 WAS	7.26a	7.45a	6.89ab
Weed-infested for 6 WAS	3.15b	4.49b	6.58c
Weed-infested for 9 WAS	-	2.27c	2.09c
Weed-infested for 12 WAS	-	-	1.30c
Weed-infested until harvest	-	-	-
SE (±)	0.309	0.321	0.355
	*	*	*
Interactions			
VxN	NS	NS	NS
VxP	NS	NS	NS
NxP	NS	NS	NS
VxNxP	NS	NS	NS

1 Crop vigour score taken using a scale of 0 to 10, where 0 represented completely dead plant and 10 represented the most vigorous crop.

2 Weeks after sowing.

3 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

4 Treatments that had not been completely applied at the time of observation.

NS, * = Not significant, significant at 5% level of probability.

Table 7 Effects of variety, nitrogen and period of weed interference on vigour scores of okra at Kadawa in 1985 dry season.

Treatments	Crop vigour score[1] at		
	6 WAS[2]	9WAS	12 WAS
Variety (V)			
V35	3.51	455	4.30
TAE-38	3.20	4.69	4.67
SE (±)	0.230	0.210	0.135
	NS	NS	NS
Nitrogen (kg/ha) (N)			
0	2.87	4.03	4.84c[3]
75	3.79	4.84	4.49b
150	3.40	4.99	5/13a
SE (±)	0.281	0.257	0.166
	NS	NS	*
Period of weed interference (P)			
Weed-free for 3 WAS	4.06bc	4.71b	3.24d
Weed-free for 6 WAS	3.55c	4.22bc	3.23d
Weed-free for 9 WAS	-[4]	6.95a	6.18bc
Weed-free for 12 WAS	-	-	6.87ab
Weed-free until harvest	-	-	-
Weed-infested for 3 WAS	4.88a	7.36a	7.62a
Weed-infested for 6 WAS	1.79d	3.57cd	5.41c
Weed-infested for 9 WAS	-	-	2.67d
Weed-infested for 12 WAS	-	-	1.06e
Weed-infested until harvest	-	-	-
SE (±)	0.221	0.238	0.236
	*	*	*
Interactions			
VxN	NS	NS	NS
VxP	NS	NS	NS
NxP	NS	NS	NS
VxNxP	NS	NS	NS

1 Crop vigour score taken using a scale of 0 to 10, where 0 represents completely dead plant and 10 represented the most vigorous crop.
2 Weeks after sowing
3 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT)
4 Treatments that had not been completely applied at the time of observation.

Treatments	Crop vigour score[1] at		
	6WAS[2]	9 WAS	12 WAS
Variety (V)			
V35	4.83	4.83	4.88
TAE-38	5.22	5.22	5.30
SE (±)	0.208	0.345	0.255
	NS	NS	NS
Nitrogen (kg/ha)			
0	4.90	4.68±	4.85
75	5.14	5.35	5.36
150	5.03	5.13	5.06
SE (±)	0.254	0.423	0.312
	NS	NS	NS
Period of weed interference (P)			
Weed-free for 3 WAS	6.11ab[3]	5.03ab	4.28d
Weed-free for 6 WAS	5.92ab	5.92a	5.28bc
Weed-free for 9 WAS	-[4]	6.31a	7.06a
Weed-free for 12 WAS	-	-	6.86a
Weed-infree until harvest	-	-	-
Weed-infested for 3 WAS	5.94ab	6.64a	6.61ab
Weed-infested for 6 WAS	3.59c	3.97bc	4.67cd
Weed-infested for 9 WAS	-	3.42bc	4.03d

Table 9 Interaction between variety and period of weed interference on vigour score of okra at 12 WAS at Kadawa in 1985 dry season.

Period of weed interference	Crop vigour score [1] at 12WAS [2]	
	V35	TAE-38
Weed-free for 3 WAS	2.98fg [3]	3.50f
Weed-free for 6 WAS	3.13f	3.32f
Weed- free for 9 WAS	5.84de	6.51bcd
Weed-free for 12 WAS	6.22cde	7.51ab
Weed-free until harvest	- [4]	-
Weed-infested for 3 WAS	7.13abc	8.10a
Weed-infested for 6 WAS	5.60de	5.22e
Weed -infested for 9 WAS	3.30f	2.03gh
Weed-infested for 12 WAS	0.77i	1.36hi
Weed-infested until harvest	-	-
SE (±)	0.345	

[1] Crop vigour score taken using a scale of 0 to 10, where 0 represented completely dead plant and 10 represented the most vigorous crop.

[2] weeks after sowing

[3] Means followed by the same (letter(s) within rows and column are not significantly different at 5% level of probability (DMRT)

[4] Treatments that had not been completely applied at the time of observation.

period increased in 1985. At Samaru,crop kept weed-free for 6 WAS did not differ significantly in vigour scores from those similarly treated for 9 WAS. However, at 12 WAS, crop kept weed-free for 6 WAS had significantly lower vigour score than those kept weed-free for 9 WAS and longer and those infested for 3 WAS only.

There was significant interaction between variety of okra and period of weed interference on crop vigour score at 12 WAS at Kadawa in 1985 dry season (Table 9). With V35, vigour score decreased with increase in period of weed infestation while no difference was observed between 12 WAS and harvest in TAE-38.

4.1.2 Number of leaves per square metre

Variety of okra did not have significant effect on the number of leaves produced per square metre at Kadawa and Samaru during the 1985 dry and wet seasons, respectively (Tables 10 and 11). However, the effect of nitrogen level on the number of leaves/m^2 at 9 WAS was only significant at Kadawa; 150 kg N/ha resulted in higher number of leaves/m^2 than 0 and 75 kg N/ha (Table 10).

Period of weed interference significantly affected number of leaves/m^2 at 6, 9 and 12 WAS. At Kadawa, crop kept weed-free for 3 and 6 WAS and those infested for 6 and 9 WAS had lower number of leaves/m^2 than those kept weed-free until 9 WAS and infested for 3 WAS only.

Table 10 Effects of variety, nitrogen and period of weed interference on number of leaves per square metre in okra at Kadawa in 1985 dry season.

Treatments	Number of leaves/m²		
	6 WAS[1]	9 WAS	12 WAS
Variety (V)			
V35	9.57	21.33	40.80
TAE-38	10.61	26.96	48.59
SE (±)	0.652	1.956	3.350
	NS	NS	NS
Nitrogen (kg/ha) (N)			
0	9.87	18/61b[2]	44.33
75	9.33	22.87b	36.74
150	11.05	31.32a	53.04
SE (±)	0.770	2.400	4.089
	NS	*	NS
Period of weed interference (P)			
Weed-free for 3 WAS	13.01ab	25.84b	22.28e
Weed-free for 6 WAS	10.87a-d	22.87b	22.40de
Weed-free for 9 WAS	-[3]	36.06a	53.66bc
Weed-free for 12 WAS	-	-	56.80abc
Weed-free until harvest	-	-	-
Weed-infested for 3 WAS	12.03ab	32.92a	78.70a
Weed- infested for 6 WAS	6.58e	23.38b	56.30abc
Weed-infested for 9 WAS	-	8.39c	46.87cd
Weed-infested for 12WAS	-	-	18,34e
Weed-infested until harvest	-	-	-
SE (±)	1.125	2.044	7.140
	*	*	*
Interactions			
VxN	NS	NS	NS
VxP	NS	NS	NS
NxP	NS	NS	NS
VxNxP	NS	NS	NS

1 Weeks after sowing
2 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT)
3 Treatments that had not been completely applied at the time of observation.
NS, * = Not significant, significant at 5% level of probability.

Treatments	Number of leaves/m²		
	6 WAS[1]	9 WAS	12 WAS
Variety (V)			
V35	16.18	17.01	12.09
TAE-38	16.74	16.74	11.76
SE (±)	1.037	1.511	0.504
	NS	NS	NS
Nitrogen (kg/ha) (N)			
0	15.76	14.58	12.71
75	16.53	18.96	12.09
150	17.07	17.10	10.96
SE (±)	1.274	1.837	0.622
	NS	NS	NS
Period of weed interference (P)			
Weed-free for 3 WAS	18.70ab[2]	23.53a	10.49bc
Weed-free for 6 WAS	12.27bc	22.10a	12.18abc
Weed-free for 9 WAS	-[3]	18.01abc	13.99ab
Weed-free for 12 WAS	-	-	13.75ab
Weed-free until harvest	-	-	-
Weed-infested for 3 WAS	17.36bc	18.19abc	12.41abc
Weed-infested for 6 WAS	12.50c	16.15abc	11.11abc

Significant reduction in leaf number of okra was observed in plots weed-infested for a further 3 weeks, that is, until 9 WAS compared with those infested for 6 WAS. At 12 WAS, crop kept weed-free for 9 WAS and less and those infested for 9 and 12 WAS had lower leaf number/m^2 compared with those crops weed-infested for 3 WAS only. However, at Samaru in 1985, there was no definite trend on the effect of period of weed interference on number of leaves produced per square metre.

4.1.3 Plant height

Variety of okra only had significant effect on plant height at 6 and 9 WAS at Samaru in 1985 wet season while N had effect on height at 6 WAS in the same trial (Tables 12, 13 and 14). Plants of TAE-38 were taller than those of V35 at 6 and 9 WAS, 75 kg N/ha resulted in taller plants only at 6 WAS than 0 and 150 kg N/ha (Table 14).

Period of weed interference had significant effect on height of okra plants at 9 WAS and final harvest in all the trials. Weed interference for the first 3 WAS did not have any adverse effect on plant height. At Kadawa in both years, okra plants on plots that were weed-infested for 6 WAS and longer and those kept weed-free initially for 3 WAS were significantly shorter than those kept weed-free until final harvest. At Samaru, in 1985 wet season, only crop kept weed-free and those infested for 6 WAS had shorter plants at 9 WAS and harvest than all other treatments

Table 12 Effects of variety, nitrogen and period of weed interference on plant height of okra at Kadawa k in 1984 dry season.

Treatments	Plant height (cm) at harvest
Variety (V)	
V35	81.74
TAE-38	76.92
SE (±)	2.188
	NS
Nitrogen (kg/ha) (N)	
0	78.35
75	80.68
150	78.96
SE(±)	2.680
	NS
Period of weed interference (P)	
Weed-free for 3 WAS[1]	56.88c[2]
Weed-free for 6 WAS	90.38a
Weed-free for 9 WAS	93.74a
Weed-free for 12 WAS	96.04a
Weed-free until harvest	97.83a
Weed-infested for 3 WAS	97.58a
Weed- infested for 6 WAS	74.55b
Weed-infested for 9 WAS	64.40c
Weed-infested for 12 WAS	62.18c
Weed-infested until harvest	59.73c
SE(±)	2.760
	*
Interactions	
VxN	NS
VxP	NS
NxP	NS
VxNxP	NS

1 Weeks after sowing.

2 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

NS, * = not significant, significant at 5% level of probability.

Table 13 Effects of variety, nitrogen and period of weed interference interference on plant height of okra at Kadawa in 1985 dry season.

Treatments	Plant height (cm) at		
	6 WAS[1]	9 WAS	harvest
Variety (V)			
V35	24.23	59.39	95.60
TAE-38	23.33	60.73	96.00
SE (±)	0.538 NS	1.787 NS	3.606 NS
Nitrogen (kg/ha) (N)			
0	23.70	57.78	90.20
75	22.75	60.00	100.60
150	24.90	62.40	96.50
SE (±)	0.659 NS	2.189 NS	4.412 NS
Period of weed interference (P)			
Weed-free for 3 WAS	23.17	67.50a[2]	85.60c
Weed-free for 6 WAS	24.39	67.00a	91.30bc
Weed-free for 9 WAS	-[3]	72.11a	111.40ab
Weed-free for 12 WAS	-	-	127.10a
Weed-free until harvest	-	-	-
Weed-infested for 3 WAS	25.33	69.17a	123.80a
Weed-infested for 6 WAS	23.83	41.61b	75.80cd
Weed-infested for 9 WAS	-	43.39b	63.10de
Weed-infested for 12 QAS	-	-	54.10e
Weed-infested f until harvest	-	-	-
SE (±)	1.107 NS	2.872 *	6.251 *
Interations			
VxN	NS	NS	NS
VxP	NS	NS	NS
NxP	NS	NS	**
VxNxP	NS	NS	NS

1 Weeks after sowing

2 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT)

3 Treatments that had not been completely applied at the time of observation.

NS, **, * = Not significant, significant at 1% and 5% levels of probability, respectively.

Table 14 Effects of variety, nitrogen and period of weed interference on plant height of okra at Samaru in 1985 wet season.

Treatments	Plant height (cm) at		
	6 WAS[1]	9 WAS	harvest
Variety (V)			
V35	24.03b[2]	27.68b	57.10
TAE-38	26.92a	37.74a	66.80
SE (±)	0.537	2.064	3.189
	*	*	NS
Nitrogen (kg/ha) (N)			
0	24.47b	31.84	62.70
75	28.17a	32.55	67.20
150	23.78b	34.01	55.90
SE (±)	0.658	2.529	3.903
	*	NS	NS
Period of weed interference (P)			
Weed-free for 3 WAS	25.44	34.92ab	72.50a
Weed-free for 6 WAS	23.51	26.21b	63.20ab
Weed-free for 9 WAS	-[3]	34.19ab	72.60ab
Weed-free for 12 WAS	-	-	66.40ab
Weed-free until harvest	-	-	64.80ab
Weed-infested for 3 WAS	22.23	31.77ab	61.90ab
Weed-infested for 6 WAS	23.93	26.44b	47.90b
Weed-infested for 9 WAS	-	35.16ab1	54.90ab
Weed-infested for 12 WAS	-	-	60.60ab
Weed-infested until harvest	-	-	54-70ab
SE (±)	1.593	2.807	5.402
	NS	*	*
Interactions			
VxN	NS	NS	NS
VxP	NS	NS	NS
NxP	NS	NS	NS
VxNxP	NS	NS	NS

1 Weeks after sowing
2 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).
3 Treatments that had not been complegely applied at the time of observation.

NS, * = Not significant, significant at 5% level of probability.

Table 15 Interaction between nitrogen and period of weed interference on plant height of okra at final harvest at Kadawa in 1985 dry season.

Period of weed interference	Plant height (cm) at final harvest		
	0	75	150
	- kg N/ha -		
Weed-free for 3 WAS	81.2f-j[2]	95.0d-j	78.8f-j
Weed- free for 6 WAS	111.8b-g	77.9g-j	84.2e-j
Weed-free for 9 WAS	97.0c-j	124.3a-d	112.8b-g
Weed-free for 12 WAS	117.2b-f	139.0ab	125.0a-d
Weed-free until harvest	105.3b-i	134.8abc	158.3a
Weed-infested for 3 WAS	108.2b-h	121.4a-e	139.7ab
Weed-infested for 6 WAS	62.2ijk	87.7d-j	70.7h-k
Weed-infested for 9 WAS	61.6jk	67.5ijk	60.2jk
Weed-infested for 12 WAS	55.6jk	37.0k	69.8h-k
Weed-infested until harvest	94.9d-j	20.3k	64.8jk
SE (±)		11.18	

1 Weeks after sowing

2 Means followed by the same letter(s) within rows and column are not significantly different at 5% level of probability (DMRT).

in the trial. Plant height did not exhibit any definite trend in response to periods of weed interference in this trial.

At Kadawa in 1985 dry season, the interaction between nitrogen level and period of weed interference was significant on okra plant height at harvest (Table 15). Without nitrogen no weed interference period resulted in plants of similar height to the tallest in the trial. At 75 kg N/ha, plots kept weed-free for 9 and 12 WAS and until harvest and those weed-infested for 3 WAS only had comparable okra plant height to those in plots kept weed-free until harvest at 150 kg N/ha.. Okra plant height on plots kept weed-free for 12 WAS and those infested for 3 WAS only were also comparable to those kept weed-free throughout the growth period at 150 kg N/ha.

4.1.4 Shoot dry matter production

Shoot dry matter production at harvest in okra was only significantly affected by variety at Kadawa in 1984 dry season (Tables 16 and 17) when TAE-38 produced higher shoot dry matter than V35. Application of 150 kg N/ha also significantly resulted in higher shoot dry matter than 0 kg N/ha at the site in 1985.

The effect of period of weed interference was significant on shoot dry matter production at 6 and 9 WAS as well as at harvest in all the trials. At 9 WAS in both

Table 16 Effects of variety, nitrogen and period of weed interference on shoot dry matter production of okra at Kadawa in 1984 and 1985 dry seasons.

Treatments	Shoot dry matter (g/m^2)			
	1984		1985	
	9 WAS[1]	harvest	9 WAS	harvest
Variety (V)				
V34	166.8	179.3b[2]	182.8	248.0
TAE- 38	179.0	234.4a	213.3	283.6
SE (±)	13.19	15.40	15.64	26.64
	NS	*	NS	NS
Nitrogen (kg/ha) (N)				
0	149.9	166.5	157.9b	226.7
75	197.9	237.0	197.9ab	281.8
150	170.7	217.2	238.5a	288.9
SE (±)	16.12	18.84	19.17	32.59
	NS	NS	*	NS
Period of weed interference (P)				
Weed-free for 3 WAS	82.7b	79.1b	193.5b	144.6de
Weed- free for 6 WAS	297.5a	261.3a	199.1b	189.6cde
Weed- free for 9 WAS	242.1a	246.0a	304.9a	285.6bc
Weed-free for 12 WAS	-[3]	274.1a	-	375.7ab
Weed-free until harvest	-	349.0a	-	430.2a
Weed-infested for 3 WAS	256.0a	328.6a	336.0a	480.6a
Weed- infested for 6 WAS	117.0b	276.4a	138.7b	286.8bc
Weed-infested for 9 WAS	73.5b	121.2a	53.9c	160.3de
Weed-infested for 12 WAS	-	71.4b	-	86.5de
Weed- infested until harvest	-	61.0b	-	39.6e
SE (±)	28.15	31.91	20.36	32.90
	*	*	*	*
Interactions				
VxN	NS	NS	NS	NS
VxP	NS	NS	NS	**
NxP	NS	NS	NS	NS
VxNxP	NS	NS	NS	NS

1 Weeks after sowing

2 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

3 Treatments that had not been completely applied at the time of observation.

NS, **, * = Not significant, significant at 1% and 5% level of probability.

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Table 17 Effects of variety, nitrogen and period of weed interference on shoot dry matter production of okra at Samaru in 1985 wet season.

Treatments	Shoot dry matter (g/m²) at		
	WAS[1]	9 WAS	harvest
Variety (V)			
V35	31.26	99.26	109.93
TAE-38	32.44	122.07	107.26
SE (±)	2.607	9.748	12.919
	NS	NS	NS
Nitrogen (kg/ha) (N)			
0	29.07	100.74	97.78
75	37.72	108.74	122.67
150	28.77	122.67	105.48
SE (±)	3.200	11.911	15.822
	NS	NS	NS
Period of weed interference (P)			
Weed-free for 3 WAS	41.99a[2]	134.52a	111.41abc
Weed-free for 6 WAS	42.84a	125.93a	127.70abc
Weed-free for 9 WAS	-[3]	131.56a	168.30a
Weed-free for 12 WAS	-	-	152.59a
Weed-free until harvest	-	-	157.93a
Weed-infested for 3 WAS	34.96ab	129.78a	132.15ab
Weed-infested for 6 WAS	22.49bc	89.78bc	72.00bcd
Weed-infested for 9 WAS	-	74.37c	59.85cd
Weed-infested for 12 WAS	-	-	70.22bcd
Weed-infested until harvest	-	-	33.78d
SE (±)	5.244	10.252	21.007
Interactions			
VxN	NS	NS	NS
VxP	NS	NS	NS
NxP	NS	NS	NS
VxNxP	NS	NS	NS

1 Weeks after sowing
2 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).
3 Treatments that had not been completely applied at the time of observation.
NS, * = Not significant, significant at 5% level of probability.

Table 18 Interaction between variety and period of weed interference on shoot dry matter production of okra at harvest at Kadawa in 1985 dry season.

Period of weed interference	Shoot dry matter (g/m^2) at harvest	
	V35	TAE-38
Weed-free for 3 WAS[1]	163.6e-h[2]	125.3gh
Weed- free for 6 WAS	196.1d-h	183.1e-h
Weed- free for 9 WAS	298.7c-f	272.9c-g
Weed-free for 12 WAS	314.4cde	437.3abc
Weed-free until harvest	326.4cde	544.6ab
Weed-infested for 3 WAS	370.1bcd	590.8a
Weed-infested for 6 WAS	308.7c-f	264.9d-g
Weed-infested for 9 WAS	184.3e-h	136.6fgh
Weed-infested for 12 WAS	110.8gh	61.9h
Weed-infested until harvest	48.9h	30.2i
S (±)	51.56	

1 weeks after sowing

2 Means followed by the same letter(s) within rows and column are not significantly different at 5% level of probability (DMRT)

years at Kadawa, okra shoot dry matter production on plots weed infested for 6 and 9 WAS and those kept weed-free for 3 WAS only were significantly lower than those infested for 3 WAS and those kept weed-free until 9 WAS. Crop kept weed-free for 3 WAS also resulted in significantly lower shoot dry matter at 9 WAS than those weed-infested for 3 WAS only and those kept weed-free until 9 WAS in 1985. At harvest in 1984, plots weed-infested until 12 WAS and harvest and those kept weed-free until 3 WAS had lower shoot dry matter while in 1985 only plots kept weed-free until 12 WAS and harvest had comparable shoot dry matter to the highest obtained on plots weed-infested until 3 WAS only.

At Samaru in 1985, okra shoot dry matter production at 9 WAS on plots weed-infested for 6 and 9 WAS were significantly lower than those kept weed-free until 9 WAS and infested for 3 WAS only. Crop weed-infested for 6 WAS until harvest had significantly lower shoot dry matter at harvest than those kept weed-free for various periods throughout crop growth and weed-infested for 3 WAS only.

There was a significant interaction between variety of okra and period of weed interference on shoot dry matter production at harvest at Kadawa in 1985 dry season (Table 18). No varietal differences was observed in shoot dry matter production when the plots were kept weed-free from 3 to 12 WAS and weed-infested for 6 to 12 WAS. However, variety TAE-38 produced significantly

higher shoot dry matter than variety V35 when the plots were kept weed-free until harvest and weed-infested for 3 WAS only. In V35, none of the periods of weed interference had comparable shoot dry matter to the maximum obtained with V35 weed-infested for 3 WAS only, while plots kept weed-free until 12 WAS and harvest were comparable in TAE-38.

4.1.5 Number of days to flowering

In all the experiments, variety TAE-38 took longer days to first, 50% and 100% flowering although this was not significant at Samaru in 1985 wet season (Tables 19, 20 and 21).

Period of weed interference had significant effect on the number of days to first, 50% and 100% flowering in all the experiments. At Kadawa in both years, crop weed-infested for 6 WAS and longer and also those kept weed-free for 3 WAS only in 1984, took significantly longer days to first flowering than the least obtained with the plots weed-infested until 3 WAS. Weed infestation for 6 WAS and longer increased the number of days to 50% and 100% flowering in okra. In 1984, crop kept weed-free for 3 WAS also took significantly longer days to 50% flowering than those kept weed-free throughout the growth period. At Samaru, no definite trend was established but crop weed-infested for 6 WAS and longer generally attained first, 50% and 100% flowering later than those kept weed-free initially.

Table 19 Effects of variety, nitrogen and period of weed interference on days to first flowering in okra at at Kadawa and Samaru.

Treatments	Days to first flowering (days)		
	Kadawa		Samaru
	1984	1985	1985
Variety (V)			
V35	45.03a[1]	45.67a	48.29
TAE-38	46.54b	47.47b	48.74
SE (±)	0.343	0.472	0.377
	*	*	NS
Nitrogen (kg/ha) (N)			
0	45.40	46.54	47.98
75	46.08	46.72	49.08
150	45.88	46.45	48.48
SE (±)	0.420	0.578	0.462
	NS	NS	NS
Period of weed interference) (P)			
Weed-free for 3 WAS[2]	47.67e	43.94a	48.28ab
Weed-free for 6 WAS	45.00a-d	46.00ab	48.06a
Weed-free for 9 WAS	44.44ab	44.78a	47.72a
Weed- free for 12 WAS	44.61abc	43.67a	47.61a
Weed-free until harvest	33.29ab	44.22a	47.61a
Weed-infested for 3 WAS	44.17a	43.61a	48.17a
Weed-infested for 6 WAS	46.17b-e	48.73bc	50.39c
Weed-infested for 9 WAS	48.06e	49.67c	48.78abc
Weed-infested for 12 WAS	46.50cde	51.44c	48.56ab
Weed-infested f until harvest	46.89de	49.61c	50.00bc
SE (±)	0.586	09.21	0.520
	*	*	*
Interactions			
VxN	NS	*	NS
VxP	NS	NS	NS
NxP	NS	NS	NS
VxNxP	NS	NS	NS

1 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

2 Weeks after sowing

Table 20 Effects of variety, nitrogen and period of weed interference on days to 50% flowering in okra at Kadawa and Samaru.

Treatments	Days to 50% flowering (days)			
	Kadawa		Samaru	
	1984	1985	1985	
Variety(V)				
V35	56.19a[1]	54.49	59.73	
TAE-38	58.42b	56.28	60.17	
SE (±)	0.700	0.634	0.327	
	*	NS	NS	
Nitrogen (kg/ha) (N)				
0	56.73	55.18	59.37	
75	57.78±	55.59	60.68	
150	57.40	55.39	59.80	
SE(±)	0.858	0.777	0.397	
	NS	NS	NS	
Period of weed interference(P)				
Weed-free for 3 WAS[2]	59.28b	52.39a	59.28a	
Weed-free for 6 WAS	55.72a	50.94a	59.56ab	
Weed-free for 9 WAS	54.89a	50.83a	59.28a	
Weed-free for 12 WAS	56.22a	51.11a	59.39a	
Weed-free foruntil harvest	55.06a	51.83a	59.61ab	
Weed-infested for 3 WAS	54.67a	52.94a	59.44a	
Weed-infested for 6 WAS	58.67b	59.75b	61.17b	
Weed-infested for 9 WAS	59.22b	62.31b	60.06ab	
Weed-infested for 12 WAS	60.28b	62.68b	60.61ab	
Weed-infested until harvest	59.06b	59.06b	61.11b	
SE (±)	0.586±	1.127	0.498	
	*	*	*	
Interactions				
VxN	NS	NS	NS	
VxP	*	NS	NS	
NxP	*	NS	NS	
VxNxP	NS	NS	NS	

1 Means followed by the same letter(s) within the same columna and treatment are not significantly different at 5% level of probability (DMRT).

2 Weeks after sowing

NS, * = Not significant, significant at 5% level of probability.

Table 21 Effects of variety, nitrogen and period of weed interference on days to 100% flowering in okra at Kadawa and Samaru.

Treatments	Days to 100% flowering (days)		
	Kadawa		Samaru
	1984	1985	1985
Variety (V)			
V35	67.14	63.44	65.30
TAE-38	69.02	66.44	65.66
SE (±)	0.887	1.044	0.286
	NS	NS	NS
Nitrogen (kg/ha) (N)			
0	67.93	65.48	64.97
75	69.20	63.78	65.97
150	67.12	65.56	65.50
SE (±)	1.086	1.278	0.350
	NS	NS	NS
Period of weed interference (P)			
Weed- free for 3 WAS	70.11c	62.78b	64.94a
Weed-free for 6 WAS	67.00ab	63.44b	65.22ab
Weed-free for 9 WAS	65.94a	60.39ab	64.67a
Weed-free for 12 WAS	66.61ab	57.19a	64.94a
Weed-free until harvest	65.44a	60.10ab	64.06a
Weed-infested for 3 WAS	65.11a	61.90b	65.11ab
Weed-infested for 6 WAS	70.50c	71.24de	67.61c
Weed-infested for 9 WAS	70.72c	75.16e	65.56ab
Weed-infested for 12 WAS	70.28c	69.51cd	65.83ab
Weed-infested until harvest	69.11bc	67.70c	66.83bc
SE (±)	0.767	1.253	0.512
	*	*	*
Interactions			
VxN	NS	NS	NS
VxP	NS	*	NS
NxP	NS	*	NS
VxNxP	NS	NS	NS

1 Weeks after sowing
2 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

3 NS, * = Not significant, significant at 5% level of probability.

At Kadawa in 1984 dry season, the interactions between variety and period of weed interference on one hand, and the period of weed interference and nitrogen on the other were significant on the number of days to 50% flowering in okra plant (Tables 22 and 23). Except when the plots were kept weed-free for the initial 3 WAS, variety V35 flowered earlier than TAE-38 when kept weed-free for various periods whereas no such differences in flowering was observed in the treatments that were initially infested with weed (Table 22). Without nitrogen, except for plots weed-infested for 6 WAS, all other treatments had comparable number of days to 50% flowering to those kept weed-free throughout the growth period. With 75 and 150 kg N/ha, crop kept weed-free for 3 WAS and those infested for 9 WAS and until harvest took more days to reach 50% flowering than those weed-free for 9 WAS (Table 23).

As shown in tables 24 and 25, the interactions between variety and period of weed interference and nitrogen and period of weed interference were significant on the number of days to 100% flowering in okra plant at Kadawa in 1985 dry season. Variety V35 reached peak of flower production earlier than variety TAE-38 when the plots were kept weed-free and weed-infested for various periods throughout the growth period (Table 24). Except in plots

Table 22 Interaction between variety and period of weed interference on days to 50% flowering in okra at Kadawa in 1984 dry season.

Period of weed interference	Days to 50% flowering (days)	
	V35	TAE-38
Weed-free for 3 WAS[1]	59.11de[2]	59.44de
Weed-free for 6 WAS	53.89abc	57.56de
Weed-free for 9 WAS	53.11a	56.67bcd
Weed-free for 12 WAS	53.44abc	59.04de
Weed-free until harvest	53.22ab	56.89de
Weed-infested for 3 WAS	53.22ab	56.11abc
Weed-infested for 6 WAS	58.55de	58.78de
Weed-infested for 9 WAS	58.78de	59.67de
Weed-infested for 12 WAS	60.00e	60.56e
Weed-infested until harvest	58.56de	59.56de
SE (±)	1.094	

[1]Weeks after sowing

[2]Means followed by the same letter(s) within rows and column are not significantly different at 5% level of probability (DMRT)

Table 23 Interaction between nitrogen and period of weed interference on days to 50% flowering in okra at Kadawa in 1984 dry season.

Period of weed interference	Days to 50% flowering (days)		
	0	75	150
	- kg N/ha -		
Weed-free for 3 WAS[1]	58.50a-d[2]	59.67bcd	56.67bcd
Weed-free for 6 WAS	56.67abc	54.50a	56.00abc
Weed-free for 9 WAS	55.33ab	54.67a	54.67a
Weed-free for 12 WAS	54.17a	57.50abc	57.00abc
Weed-free until harvest	54.33a	55.30ab	55.33ab
Weed-infested for 3 WAS	54.67a	54.33a	55.00ab
Weed-infested for 6 WAS	60.33cd	58.50a-d	57.17abc
Weed-infested for 9 WAS	56.00abc	62.17d	59.50bcd
Weed-infested for 12 WAS	58.50a-d	62.33d	60.00cd
Weed- infested until harvest	58.84a-d	58.67a-d	59.67bcd
SE (±)		1.344	

1 Weeks after sowing

2 Means followed by the same letter(s) within rows and column are not significantly different at 5% level of probability (DMRT).

Table 24 Interaction between variety and period of weed interference on days to 100% flowering in okra at Kadawa in 1985 dry season.

Period of weed interference	Days to 100% flowering (days)	
	V35	TAE-38
Weed-free for 3 WAS[1]	59.44ab[2]	66.11c-f
Weed- free for 6 WAS	59.88abc	67.00d-g
Weed-free for 9 WAS	59.22ab	61.56a-d
Weed-free for 12 WAS	56.56a	57.83ab
Weed- free until harvest	56.92ab	63.28b-e
Weed-infested for 3 WAS	61.14a-d	62.67a-e
Weed-infested for 6 WAS	69.04e-h	73.44ghi
Weed-infested for 9 WAS	76.38i	73.94hi
Weed-infested for 12 WAS	66.74d-g	72.29f-i
Weed- infested until harvest	69,12e-h	66.27c-f
SE (±)	1.979	

1 weeks after sowing

2 Means followed by the same letter(s) within rows and column are not significantly different at 5% level of probability(DMRT)

Table 25 Interaction between nitrogen and period of weed interference on days to 100% flowering in okra at Kadawa in 1985 dry season.

Period of weed interference	Days to 100% flowering (days)		
	0	75	150
		- kg N/ha -	
Weed-free for 3 WAS[1]	61.75b-g[2]	60.50f-e	66.08c-i
Weed-free for 6 WAS	58.17abc	64.71c-i	67.44f-i
Weed-free for 9 WAS	63.92b-h	58.83a-d	58.42a-d
Weed-free for 12 WAS	61.00b-e	52.33a	58.25abc
Weed-free until harvest	62.17b-g	60.38b-e	57.75ab
Weed-infested for 3 WAS	64.17b-i	61.71b-f	59.83a-e
Weed-infested for 6 WAS	72.02hij	69.63f-j	72.08hij
Weed-infested for 9 WAS	72.52ij	77.03j	75.90j
Weed-infested for 12 WAS	72.79ij	65.55c-i	70.19g-j
Weed-infested until harvest	66.24c-i	67.16d-i	69.69f-j
SE (±)		2.424	

1 Weeks after sowing

2 Means followed by the same letter(s) within rows and column are not significantly different at 5% level of probability (DMRT).

kept weed-free for 3 and 6 WAS, number of days to 100% flowering in okra decreased with increase in nitrogen level from 0 to 150 kg N/ha in plots kept weed-free for the remaining part of the crop growth period while in weed-infested treatments, days to 100 % flowering decreased with increase in nitrogen level only in plots weed-infested for 3 WAS (Table 25).

4.1.6 Fruit yield

The number and weight of fruits produced per plant are important components of yield in okra.

4.1.6.1 Fruit number

Neither variety of okra nor level of nitrogen had significant effect on the number of fruits produced per square metre in all the experiments (Table 26). However, period of weed interference significantly affected the number of fruits produced per unit area of land. Weed infestation for 6 WAS and longer resulted in significantly lower fruit number per square metre than those weed-infested for 3 WAS only. At Kadawa in 1984, plots kept weed-free for 3 WAS and those kept weed-free for 3, 6 and 9 WAS in 1985 resulted in significantly lower fruit number per square metre than those kept weed-free throughout the growth period.

Table 26 Effects of variety, nitrogen and period of weed interference on fruit number per square metre at Kadawa and Samaru.

Treatments	Number of okra fruits (No./m²)		
	Kadawa		Samaru
	1984	1985	1985
Variety (V)			
V35	9.24	16.27	8.54
TAE-38	9.66	19.61	11.13
SE (±)	0.924	1.389	2.477
	NS	NS	NS
Nitrogen (kg/ha) (N)			
0	8.31	15.64	9.21
75	10.67	18.47	9.96
150	9.39	19.72	10.34
SE (±)	1.132	1.701	3.035
Period of weed interference (P)			
Weed-free for 3 WAS[1]	1.50b[2]	15.96c	10.86ab
Weed-free for 6 WAS	14.37a	11.02cd	11.85ab
Weed-free for 9 WAS	13.04a	24.31b	14.47a
Weed-free for 12 WAS	15.86a	29.17ab	16.27a
Weed-free until harvest	16.84a	34.39a	16.71a
Weed-infested for 3 WAS	17.51a	34.21a	19.20a
Weed-infested for 6 WAS	5.84b	15.61c	4.43bc
Weed-infested for 9 WAS	3.67b	5.96d	3.91bc
Weed-infested for 12 WAS	2.90b	3.94d	1.67c
Weed- infested until harvest	2.92b	4.87d	1.00c
SE (±)	1.333	2.126	2.568
	*	*	*
Interactions			
VxN	NS	NS	NS
VxP	NS	NS	NS
NxP	*	NS	NS
VxNxP	NS	NS	NS

1 Weeks after sowing
2 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).
NS, * = Not significant, significant at 5% level of probability.

Table 27 Interaction between nitrogen and period of weed interference on fruit number/m² of okra at Kadawa in 1984 dry season.

Period of weed interference	Fruit number/m²		
	0	75 kg N/ha	150
Weed-free for 3 WAS[1]	1.53h[2]	1.05h	1.90h
Weed-free for 6 WAS	11.53c-g	12.20c-f	14.34bcd
Weed-free for 9 WAS	11.33c-g	13.00b-e	14.79bcd
Weed-free for 12 WAS	16.00a-d	15.81a-d	15.78a-d
Weed-free until harvest	15.26a-d	22.93ab	19.41a-d
Weed-infested for 3 WAS	15.29a-d	23.81a	13.75b-e
Weed-infested for 6 WAS	4.18fg	7.82d-g	5.50efg
Weed-infested for 9 WAS	4.44efg	3.14g	3.44g
Weed-infested for 12 WAS	2.58h	3.67g	2.47h
Weed-infested until harvest	0.93h	5.26efg	2.56h
SE (±)	2.47		

1 Weeks after sowing

2 Means followed by the same letter(s) within rows and column are not significantly different at 5% level of probability (DMRT).

Interaction between nitrogen level and period of weed interference was significant on fruit number per square metre at Kadawa in 1984 dry season (Table 27). In all cases, plots kept weed-free for 9 WAS and less and those weed-infested for 6 WAS and more had significantly lower fruit number per square metre than those kept weed-free for 12 WAS and throughout the growth period irrespective of nitrogen level. With 150 kg N/ha, plots weed-infested for 3 WAS also had lower fruit number per square metre than those kept weed-free until harvest.

4.1.6.2 Fruit weight

As shown in Table 28, variety of okra and level of nitrogen did not have significant effect on fruit weight in all the experiments. However, period of weed interference significantly affected okra fruit weight. At Kadawa in 1984 dry season, maximum fruit weight of 8.80 t/ha was obtained when crops were kept weed-free throughout the crop growth period. Plots weed-infested for 6 WAS and more and those kept weed-free for 12 WAS and less had significantly lower fruit yield than the maximum obtained when plots were kept weed-free until harvest. The highest gain in okra fruit weight of 1.68 t/ha per week was obtained when the crop was kept weed-free for a further 3 weeks beyond the first 3 WAS. At the same location in 1985, maximum okra fruit weight of 11.30 t/ha was obtained in plots weed-infested for 3 WAS only; the

Table 28 Effects of variety, nitrogen and period of weed interference on weight of okra fruits at Kadawa and Samaru.

Treatments	Fruit weight (t/ha)		
	Kadawa		Samaru
	1984	1985	1985
Variety (V)			
V35	4.51	5.42	5.62
TAE-38	3.91	5.55	6.20
SE (±)	0.438	0.552	1.143
	NS	NS	NS
Nitrogen (kg/ha) (N)			
0	3.63	4.45	5.58
75	4.74	5.47	6.04
150	4.26	6.53	6.12
SE (±)	0.536	0.676	1.040
	NS	NS	NS
Period of weed interference (P)			
Weed-free for 3 WAS[1]	0.84f[2]	3.65cd	6.93e
Weed-free for 6 WAS	5.83cd	4.11cde	7.24de
Weed-free for 9 WAS	5.61d	8.16b	8.70c
Weed-free for 12 WAS	7.17bc	9.47ab	10.00b
Weed-free until harvest	8.80a	11.00a	12.10a
Weed-infested for 3 WAS	8.15ab	11.30a	8.56cd
Weed-infested for 6 WAS	2.30e	4.43c	2.32f
Weed-infested for 9 WAS	1.20f	1.56de	1.80f
Weed-infested for 12 WAS	1.07f	1.01e	1.18fg
Weed-infested until harvest	1.08f	1.10e	0.27g
SE (±)	0.565	0.677	1.124
	*	*	*
Interactions			
VxN	NS	NS	NS
VxP	NS	NS	NS
NxP	*	NS	NS
VxNxP	NS	NS	NS

1 Weeks after sowing.
2 Means followed by the same letter(s) within the same column and treatment are significantly different at 5% level of probability (DMRT).
NS, * = Not significant, significant at 5% level of probability

weight was also comparable to that obtained in plots kept weed-free throughout the crop growth period. Plots weed-infested for 6 WAS and longer and those kept weed-free for 9 WAS and less resulted in significantly lower fruit weight than the maximum obtained in the trial. However, the highest gain of 1.68 t/ha per week was obtained when the crop was kept weed-free for a further 3 weeks beyond the first 6 WAS. At Samaru in the 1985 wet season, maximum fruit weight of 12.10 t/ha was obtained in plots kept weed-free throughout the crop growth period. The plots weed-infested for 3 WAS and more and those kept weed-free for 12 WAS and less had significantly lower fruit weight than the maximum obtained in the trial when plot was kept weed-free throughout the growth period. The highest gain in fruit weight of 0.70 t/ha per week was obtained when the crop was kept weed-free beyond 12 WAS. Conversely, the highest reduction in okra fruit weight of 1.95, 2.08 and 2.30 t/ha per week in the 1984, 1985 dry and 1985 wet seasons respectively were obtained when the crop was weed-infested for a further 3 weeks beyond the first 3 WAS. In these experiments, uncontrolled weed growth throughout the crop life-cycle reduced okra fruit weight by 86 and 90 % during the 1984 and 1985 dry seasons, respectively and 98% in the 1985 wet season compared with those of the crops kept weed-free throughout the growth period.

The interaction between nitrogen and period of weed interference was significant on fruit weight at Kadawa in the 1984 dry season (Table 29). Maximum weight of okra fruits was obtained with the crop weed-infested for 3 WAS and given 75 kg N/ha. Yield of the plot kept weed- free until harvest and treated with 150 kg N/ha was comparable. When kept weed-free for 6 and 9 WAS and until harvest, application of 150 kg N/ha resulted in significantly higher fruit weight than no nitrogen while 75 kg N/ha was only better than 0 kg N/ha when crop was kept weed-free throughout the growth period. Nitrogen at the rate of 75 kg/ha produced significantly higher fruit yield than 0 and 150 kg N/ha in plots weed-infested for 3 and 6 WAS.

Figures 3 to 5 show curves of predicted values of okra fruit yield for varieties V35 and TAE-38 as affected by period of weed interference. At Kadawa during the 1984 dry season, maximum fruit yields for varieties V35 and TAE-38 were obtained when the crops were kept weed-free through the growth period (Fig. 3). If kept weed-free initially, maximum yields in V35 and TAE-38 would be obtained on plots kept weed-free for 69 and 95 days, respectively. For 25 and 37 % reduction in the potential okra fruit yields of varieties V35 and TAE-38, weed-free periods of 15 to 69 days and 27 to 95 days respectively were required.

Table 29 Interaction between nitrogen and period of weed interference on fruit weight of okra at Kadawa in 1984 dry season.

Period of weed interference	Fruit weight (t/ha)		
	0	75	150
		- kg N/ha -	
Weed-free for 3 WAS[1]	0.55h[2]	0.82h	1.14h
Weed-free for 6 WAS	5.39ef	3.16ef	7.10cd
Weed-free for 9 WAS	4.54fg	5.77def	6.53cde
Weed-free for 12 WAS	6.96cd	7.28c	7.28c
Weed-free until harvest	7.40c	9.30b	9.69ab
Weed-infested for 3 WAS	7.33c	11.12a	5.90c-f
Weed- infested for 6 WAS	1.35h	3.69g	1.84h
Weed-infested for 9 WAS	1.37h	1.01h	1.22h
Weed-infested for 12 WAS	0.82h	1.43h	0.973h
Weed-infested until harvest	0.59h	1.76h	0.88h
SE (±)		1.224	

1 Weeks after sowing

2 Means followed by the same letter(s) within rows and column are not significantly different at 5% level of probability (DMRT).

x——x Initially weed-free (WF) in V35 ($Y = -1.081 + 0.416Z_1 - 0.46Z_2$)

x- - - -x Initially weed-free in TAE-38 ($Y = 0.273 + 0.188Z_1 - 0.018Z_2$)

o——o Initially weed-infested (W1) in V35 ($Y = 10.983 - 0.457Z_1 + 0.049Z_2$)

o- - - -o Initiallially weed-infested in TAE-38 ($Y = 9.971 - 0.412Z_1 + 0.045Z_2$)

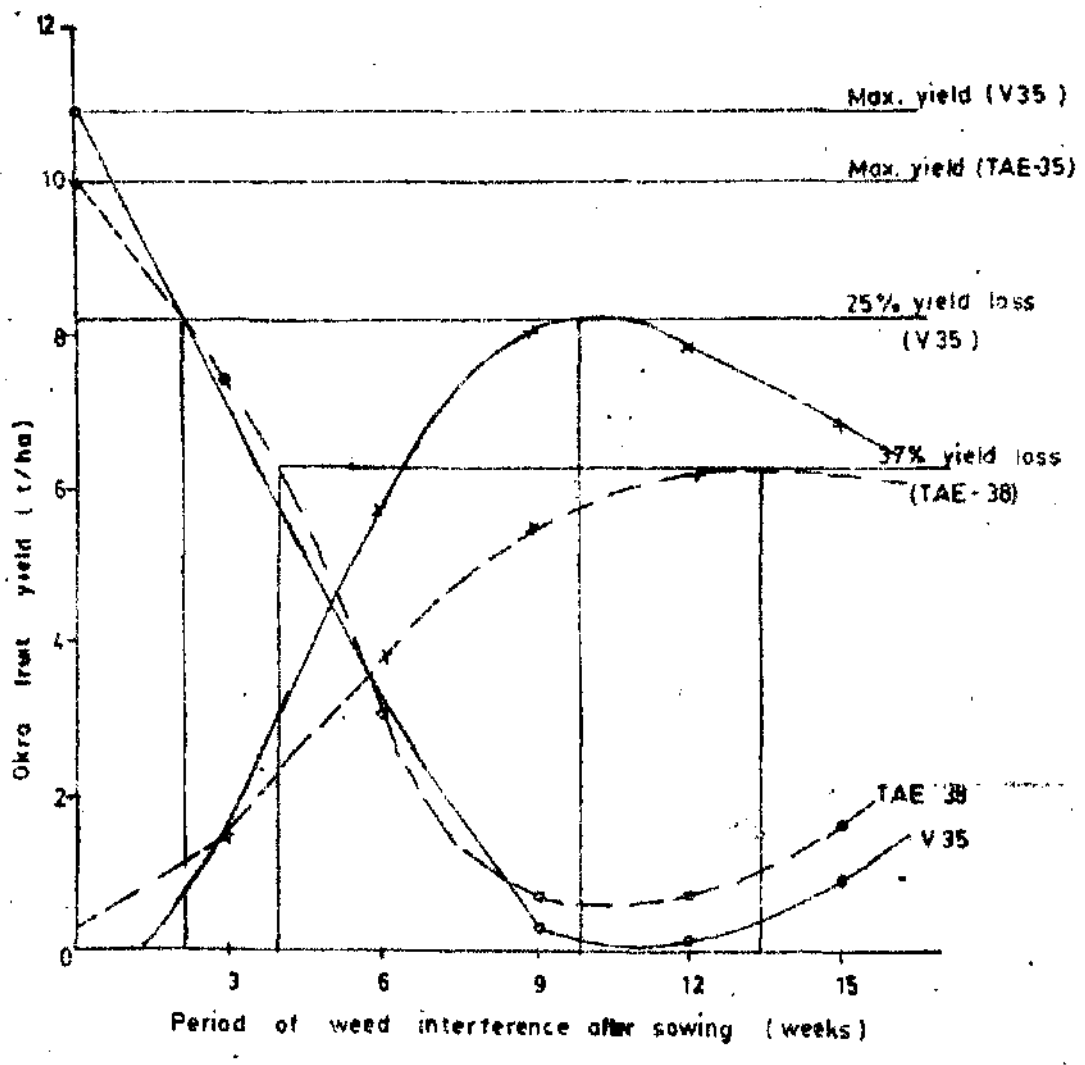


Fig. 3: Okra fruit yield as affected by period of weed interference at Kadawa during the 1984 dry season

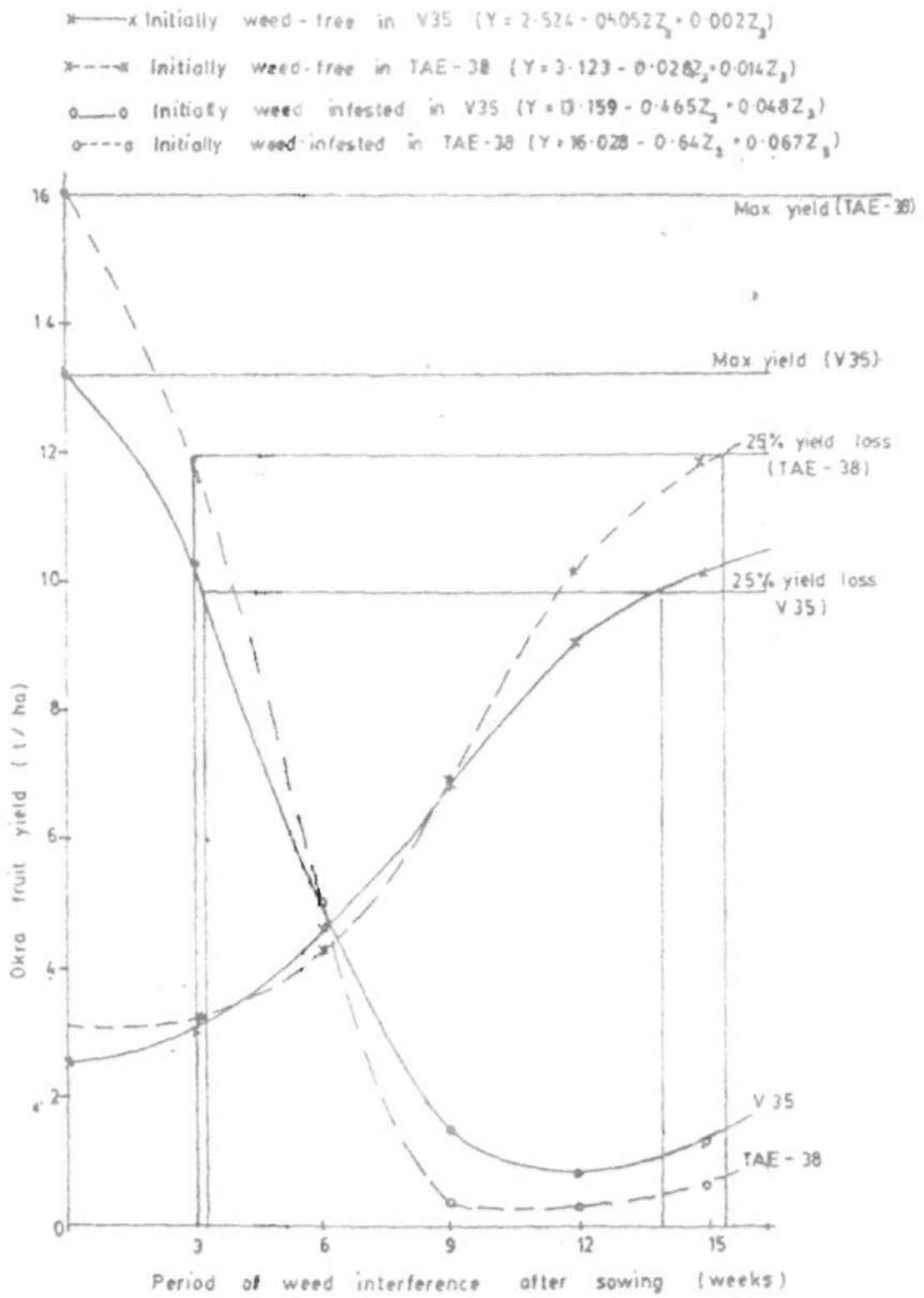


Fig. 4: Okra fruit yield as affected by period of weed interference at Kadawa during the 1985 dry season

x——x Initially weed free in V35 ($Y = 5{\cdot}414 + 0{\cdot}036Z_2 + 0{\cdot}001Z_3$)

x——x Initially weed free in TAE 38 ($Y = 9{\cdot}134 - 0{\cdot}177Z_1 + 0{\cdot}028Z_2$)

o——o Initially weed infested in V35 ($Y = 11{\cdot}123 - 0{\cdot}49Z_1 + 0{\cdot}054Z_3$)

o- - -o Initially weed infested in TAE 38 ($Y = 9{\cdot}771 - 0{\cdot}288Z_1 + 0{\cdot}027Z_3$)

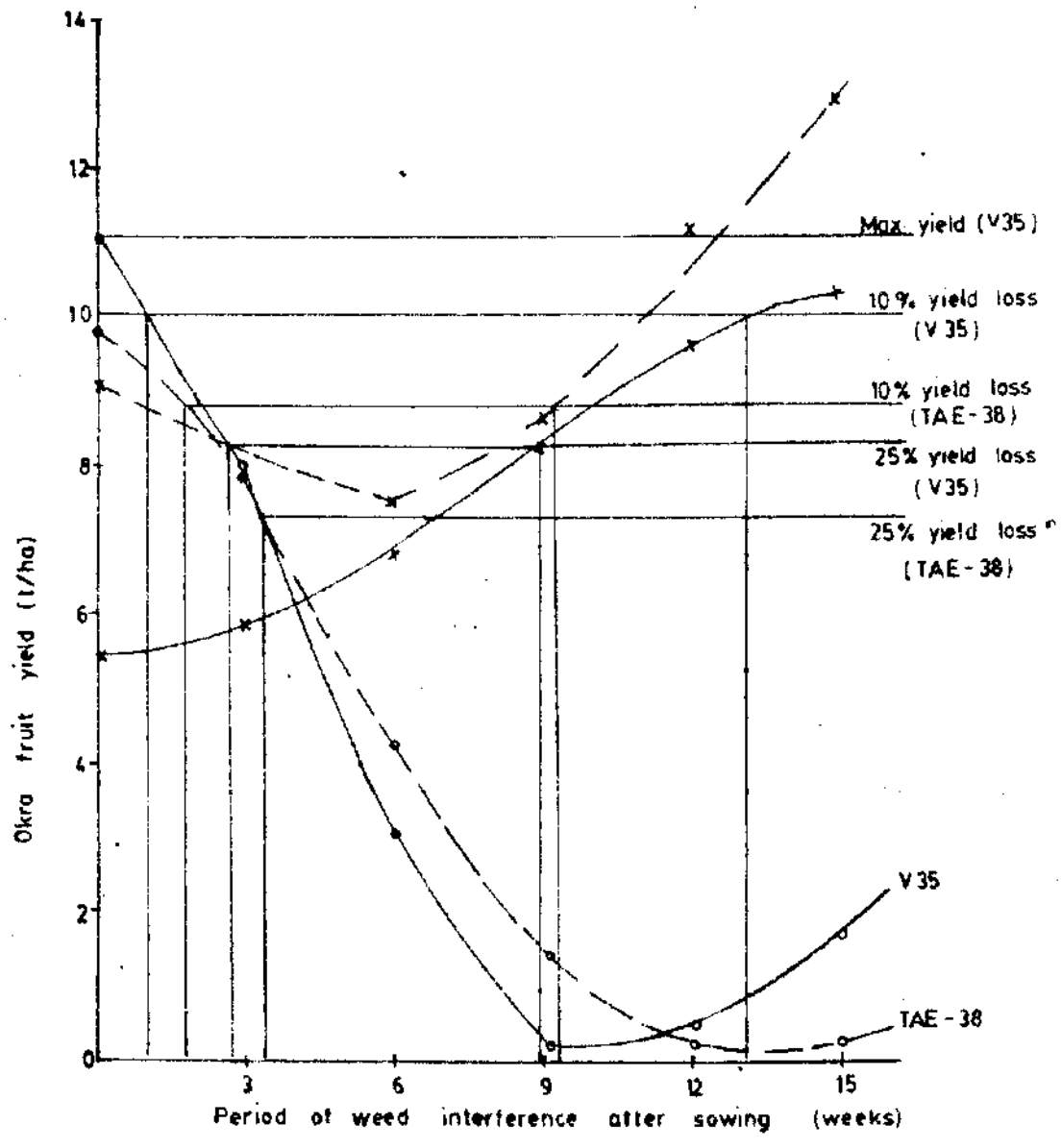


Fig. 5: Okra fruit yield as affected by period of weed interference at Samaru during 1985 wet season.

Similarly, at the same site in 1985, maximum yields of both varieties were obtained when the crops were kept weed- free throughout the growth period (Fig. 4). Loss in yield of 25% for V35 and TAE-38 occurred when the crops were infested by weeds from 23 to 97 days and 21 to 107 days after sowing, respectively.

At Samaru in 1985 wet season, maximum yields of both varieties were also obtained on plots kept weed-free throughout the growth period (Fig. 5) while 25% reduction in yields of V35 and TAE-38 occurred on plots weed-infested from 19 to 63 days and from 0 to 23 days after sowing, respectively.

4.1.7 Weed cover score and weed dry matter production

4.1.7.1 Weed cover score

Variety of okra did not have significant effect on weed cover in all the experiments (Tables 30 and 31). However, at Kadawa in the 1985 dry season, nitrogen application at 75 kg/ha resulted in significantly higher weed cover score than no nitrogen.

Period of weed interference had significant effect on weed cover at 6 and 9 WAS in all the experiments and at 12 WAS at Samaru in 1985 wet season. Plots weed infested for the first 3 WAS only had significantly lower weed cover than the maximum obtained at each observation while plots kept weed-free initially for 3 WAS were

Table 30 Effects of variety, nitrogen and period of weed interference on weed cover score in okra at Kadawa in 1984 and 1985 dry seasons.

Treatments	Weed cover score[1] at			
	1984		1985	
	6 WAS[2]	9 WAS	6 WAS	9 WAS
Variety (V)				
V35	6.41a[3]	5.53	5.63	5.66
TAE-38	6.85b	5.54	5.64	5.48
SE (±)	0.093	0.131	0.113	0.103
	NS	NS	NS	NS
Nitrogen (kg/ha) (N)				
0	6.74	5.51	5.65	5.31
75	6.44	5.52	5.49	5.89b
150	6.71	5.59	5.78	5.52ab
SE (±)	0.114	0.162	0.142	0.134
	NS	NS	NS	*
Period of weed interference (P)				
Weed-free for 3 WAS[2]	9.68b	10.00b	2.75a	8.64b
Weed-free for 6 WAS	3.25a	3.02a	2.71a	8.46b
Weed-free for 9 WAS	-[4]	2.59a	-	1.69a
Weed-free for 12 WAS	-	-	-	-
Weed-free until harvest	-	-	-	-
Weed-infested for 3 WAS	3.48a	2.52a	2.58a	1.87a
Weed-infested for 6 WAS	10.00b	2.70a	10.00b	1.95a
Weed-infested for 9 WAS	-	10.00b	-	9.53c
Weed-infested for 12 WAS	-	-	-	-
Weed-infested until harvest	-	-	-	-
SE (±)	0.203	0.222	0.331	0.236
	*	*	*	*
Interactions				
VxN	NS	NS	NS	NS
VxP	NS	NS	NS	NS
NxP	NS	NS	NS	NS
VxNxP	NS	NS	NS	NS

1 Weed cover score was taken using a scale of 0 to 10, where 0 represented no weed cover and 10 represented completed weed cover.

2 Weeks after sowing.

3 Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (DMRT).

4 Treatmentm that had not been completely applied at the time of observation.

NS, * = Not significant, significant at 5% level of probability.

Table 31 Effects of variety, nitrogen and period of weed interference on weed cover score in okra at Samaru ain 1985 wet season.

Treatments	Weed cover score[1] at 6 WAS[2]	9 WAS	12 WAS
Variety (V)			
V35	5.28	4.90	4.80
TAE-38	5.20	5.12	4.66
SE (±)	0.201	0.283	0.133
Nitrogen 8(kg/ha)(N)			
0	5.19	4.88	4.46
75	5.21	4.90	4.73
150	5.32	5.24	4.99
SE (±)	0.254 NS	0.342 NS	0.162 NS
Period of weed interference(P)			
Weed- free for 3 WAS	5.75a[3]	5.72ab	8.25c
Weed-free for 6 WAS	3.73a	3.39a	4.08b
Weed-free for 9 WAS	-[4]	3.56a	2.42a
Weed-free for 12 WAS	-	-	2.85ab
Weed-free until harvest	-	-	-
Weed-infested for 3 WAS	3.44a	3.17a	2.44a
Weed-infested for 6 WAS	7.86b	3.19a	2.72ab
Weed-infested for 9 WAS	-	8.97c	2.89ab
Weed-infested for 12 WAS	-	-	9.14c
Weed-infested until harvest	-	-	-
SE (±)	0.296 *	0.590 *	0.423 *
Interactions			
VxN	NS	NS	NS
VxP	NS	NS	NS
NxP	NS	NS	NS
VxNxP	NS	NS	NS

1 Weed cover score was taken using a scale of 0 to 10, where 0 represented no weed cover and 10 represented complete weed cover.

2 Weeks after sowing.

3 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

4 Treatments that had not been completely applied at the time of observation.

NS, * = Not significant, significant at 5% level of probability.

comparable in 1984 dry season and at 12 WAS in 1985 wet season. At Kadawa, plots weed-infested for 6 WAS had comparable weed scores to those kept weed-free for 3 WAS only at 6 WAS, while they had lower scores at 9 WAS. At 12 WAS, in 1985 wet season at Samaru, plots weed-infested for 12 WAS and those kept weed-free for 3 and 6 WAS had significantly higher weed cover than those kept weed-free for 6, 9 and 12 WAS and those infested for 3, 6 and 9 WAS.

4.1.7.2 Weed dry matter production

At Kadawa in 1984, harvested weed samples were mixed up and no reliable results could be obtained. At Kadawa and Samaru in 1985 dry and wet seasons respectively, variety of okra did not have significant effect on dry matter production of various categories of weeds (Tables 32 and 33). Broadleaved and total weed dry matter production were significantly increased by nitrogen levels in 1985 wet season (Table 33). Application of 150 kg N/ha resulted in significantly higher broadleaved and total weed dry matter than 0 and 75 kg N/ha which had similar values.

Period of weed interference significantly affected dry matter production of various categories of weeds. In both seasons, plots weed-infested for 6 WAS and more and those kept weed-free for 3 and 6 WAS only resulted in significantly higher grass weed dry matter than the least obtained on those kept weed-free until harvest. At Kadawa

Table 32 Effects of variety, nitrogen and period of weed interference on cummulative weed dry matter production in okra at Kadawa in 1985 dry season.

Treatments	Weed dry matter (t/ha)			
	Grasses	Broad-leaved weeds	Sedges	Total
Variety (V)				
V35	1.18	1.21	0.81	3.20
TAE- 38	1.13	1.13	0.94	3.20
SE (±)	0.081	0.060	0.074	0.215
	NS	NS	NS	NS
Nitrogen (kg/ha) (N)				
0	1.06	1.03	0.76	2.85
75	1.16	1.29	0.98	3.43
150	1.21	1.20	0.89	3.30
SE (±)	0.099	0.073	0.091	0.236
	NS	NS	NS	NS
Period of weed interference (P)				
Weed-free for 3 WAS[1]	1.52bc[2]	1.54bcd	1.48de	4.53c
Weed-free for 6 WAS	1.48bc	1.64cd	1.71de	4.83c
Weed-free for 9 WAS	1.63c	1.52cd	1.29cd	4.54c
Weed-free for 12 WAS	1.08ab	1.06ab	0.95bc	3.09b
Weed-free until harvest	0.72a	0.86a	0.45a	1.73a
Weed-infested for 3 WAS	0.60a	0.63a	0.60ab	1.83a
Weed-infested for 6 WAS	1.34bc	0.90a	0.35a	0.60ab
Weed-infested for 9 WAS	1.30bc	1.49bc	0.31a	3.10b
Weed-infested for 12 WAS	1.56bc	1.62cd	1.57de	4.75c
Weed-infested until harvest	1.62c	2.06d	1.44de	5.12c
SE (±)q	0.145	0.159	0.120	0.424
	*	*	*	*
Interactions				
VxN	NS	NS	NS	NS
VxP	NS	NS	NS	NS
NxP	NS	NS	NS	NS
VxNxP	NS	NS	NS	

1 Weeks after sowing.
2 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).
3 NS, * = Not significant, significant at 5% level of probability.

Table 33 Effects of variety, nitrogen and period of weed interference on cummulative weed dry matter production in okra at Samaru in 1985 wet season.

Treatment	Weed dry matter (t/ha)		
	Grasses	Broad-leaved weeds	Total
Variety (V)			
V35	1.57	2.42	3.99
TAE-38	1.81	2.24	4.05
SE (±)	0.092 NS	0.075 NS	0.167 NS
Nitrogen (kg/ha) (N)			
0	152	2.22a[1]	3.74a
75	1.61	2.16a1	3.77a
150	1.93	2.62b	4.55b
SE (±)	0.113 NS	0.0912 *	0.204 *
Pw Period of weed interference (P)			
Weed-free for 3 WAS[2]	1.70bc	2.30bc	4.00bc
Weed-free ffor 6 WAS	1.68bc	2.20abc	3.88abc
Weed-free for 9 WAS	1.25ab	1.92abc	3.17ab
Weed-free for 12 WAS	1.24ab	1.80ab	3.04a
Weed-free until harvest	1.12a	1.72ab	2.84a
Weed-infested for 3 WAS	1.29ab	1.60a	2.89a
Weed-infested for 6 WAS	1.64bc	2.14abc	3.78abc
Weed-infested for 9 WAS	1.92c	2.57c	4.49c
Weed-infested for 12 WAS	2,46d	3.47d	5.93d
Weed-infested until harvest	2.59d	3.50d	6.19d
SE (±)	0.146 *	0.214 *	0.360 *
Interactions			
VxN	NS	NS	NS
VxP	NS	NS	NS
NxP	NS	NS	NS
VxNxP	NS	NS	NS

1 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT)

2 Weeks after sowing.

NS, * = Not significant, significant at 5% level of probability

in 1985 dry season, plots kept weed-free for 9 WAS also had higher grass dry matter than the least obtained. In both trials, higher broadleaved weed dry matter production were obtained in plots weed-infested for 9 WAS and more and those kept weed-free for 6 and 9 WAS also resulted in higher broadleaved weed dry matter than the least obtained.

There was no sedge weed infestation at Samaru in 1985 wet season. At Kadawa in 1985 dry season, plots kept weed-free for 12 WAS and less and those weed-infested for 12 WAS and until harvest produced higher sedge dry matter than those kept weed-free until harvest. Weed-infestation for 9 WAS and longer and weed-free period for 3 WAS only resulted in significantly higher total weed dry matter production than the least obtained in plots kept weed-free until harvest in both trials. In 1985 dry season, total weed dry matter production were also higher in plots kept weed-free for 12 WAS and less compared with those kept weed-free throughout the growth period.

4.1.8 Relationship between various parameters and fruit yields of okra in the weed interference studies at Kadawa and Samaru

Okra fruit yield was positively correlated with crop vigour score at 12 WAS, plant height and shoot dry matter at harvest and fruit number per square metre in all the experiments at 1% level of probability (Table 34). In addition, fruit yield at harvest was negatively correlated with weed cover score at 9 WAS and number of days to 50% flowering in all the trials and total weed weight at Samaru in 1985 wet season only.

Table 34 Relationship between various parameters and fruit yield of okra in the weed interference studies at Kadawa and Samaru.

Parameters	r value		
	Kadawa 1984	Kadawa 1985	Samaru 1985
Crop vigour score at 12 WAS	0.805**	0.839**	0.792**
Weed cover score at 9 WAS	-0.607**	-0.657**	-0.302**
Plant height at harvest	0.767**	0.653**	0.329**
Shoot dry matter at harvest	0.629**	0.613**	0.585**
Number of days to 50% flowering	-0.489**	-0.335**	-0.355**
Fruit number/m^2	0.967**	0.878**	0.692**
Total weed weight	-	-0.114NS	-0.394**

Values above 0.254(**) are significant at 1% level.

NS = not significant

4.2 Effects of Variety and Weed Control Treatments on Weeds, Growth and Yield of Okra

The effects of variety and weed control treatments on weeds are shown in Tables 35 to 38, while the effects on growth and yield of okra are shown in Tables 39 to 69.

4.2.1 Weed cover score

Weed cover score at 9 WAS was only significantly affected by variety of okra at Samaru in 1985 wet season. Higher score was obtained under variety TAE-38 than V35. However, in all the experiments, weed control treatments significantly affected weed cover (Tables 36 to 38). At Kadawa in 1984 dry season, all the herbicide treatments resulted in significantly lower weed score at 6 WAS than the untreated check but higher than the hoe-weeded control. At the same location in 1985, mixtures of metolachlor with terbutryne and prometryne, and pendimethalin with terbutryne and prometryne, each at 2.0 + 1.0 fb 1.0 + 0.5 kg a.i./ha had weed scores at 6 WAS that were comparable with the hoe-weeded control. At 9 WAS, all the herbicide treatments followed by supplementary hoe-weeding at 6 WAS except pendimethalin plus terbutryne gave weed scores that were comparable to the hoe-weeded control.

At Samaru in 1984 wet season, all the herbicide treatments resulted in significantly lower weed scores at 6 and 9 WAS than the untreated check (Table 37).

All mixtures followed by supplementary herbicide application resulted in comparable weed scores at 6 WAS to the hoe- weeded control. These herbicides treatments irrespective of pre-emergence rates were significantly lower in scores than their mixtures at 2.0 + 1.0 kg a.i./ha alone. At 9 WAS, all the herbicide mixtures followed by supplementary hoe-weeding had comparable weed scores to the hoe-weeded control. Mixtures of metolachlor with terbutryne and metolachlor plus prometryne, each at 2.0 + 1.0 kg a.i./ha followed by 1.0 + 0.5 kg a.i./ha also had weed scores comparable to the hoe-weeded control. In addition, the herbicide treatments indicated had significantly lower scores than their corresponding pre-emergence treatments alone.

In 1985 wet season, all the herbicide treatments resulted in lower weed scores at 6 WAS compared with the untreated check (Table 38). The lowest weed score was also comparable to the remaining metolachlor-based treatments and pendimethalin plus terbutryne at 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha. At 9 WAS, only the high rates of herbicide mixtures followed by supplementary hoe-weeding at 6 WAS resulted in weed scores that were comparable to the hoe-weeded control.

4.2.2 Weed dry matter production

Variety of okra had non-significant effect on weed dry matter.

Weed dry matter production in okra was significantly affected by weed control treatments in all the trials. At Kadawa in 1984 dry season, all other herbicide treatments except diphenamid plus prometryne at 1.0 + 0.5 kg a.i./ha and alachlor plus prometryne at 2.0 + 1.0 kg a.i./ha resulted in comparable weed dry matter at 6 WAS to the hoe-weeded control (Table 35). In 1985 dry season, mixtures of metolachlor with terbutryne and pendimethalin at 2.0 + 1.0 and 1.0 + 0.5 kg a.i./ha respectively, each followed by 1.0 + 0.5 kg a.i./ha resulted in significantly lower weed dry matter production than the maximum obtained in the trial (Table 36).

At Samaru in 1984 wet season, mixtures of pendimethalin with terbutryne and prometryne and metolachlor plus terbutryne, each at 2.0 + 1.0 kg a.i./ha as well as pendimethalin plus terbutryne at 1.0 + 0.5 kg a.i./ha, all followed by the herbicide applied post-emergence at 1.0 + 0.5 kg a.i. /ha and all the treatments of metolachlor plus prometryne resulted in significantly lower weed dry matter production at 6 WAS than the untreated control but similar to the hoe-weeded check (Table 37). At the same location in 1985 wet season, all the treatments of metolachlor plus terbutryne at 2.0 + 1.0 kg a.i./ha, metolachlor plus

Table 35: Effects of variety and weed control treatments on weed cover and weed dry matter production in okra at Kadawa in 1984 dry season.

Treatments		Weed cover score[1] at 6 WAS[2]	Weed dry matter at 6 WAS (t/ha)
Variety			
V35		5.77	1.44
TAE-38		5.75	1.58
SE (±)		0.231 NS	0.134 NS
Weed control[+]	Rate (kg a.i/ha)		
Metolachlor+terbutryne	1.0+0.5	5.05b[3]	1.74a-d
Metolachlor+terbutryne	2.0+1.0	5.15b	0.98ab
Metolachlor+prometryne	1.0+0.5	5.68b	0.84a
Metolachlor+prometryne	2.0+1.0	5.42b	1.36a-d
Diphenamid+terbutryne	1.0+0.5	6.02b	1.51a-d
Diphenamid+terbutryne	2.0+1.0	6.48b	1.05ab
Diphenamid+prometryne	1.0+0.5	6.45b	2.04cd
Diphenamid+prometryne	2.0+1.0	5.22b	1.07ab
Pendimethalin+terbutryne	1.0+0.5	5.97b	1.08ab
Pendimethalin+terbutryne	2.0+1.0	7.00b	1.93a-d
Pendimethalin+prometryne	1.0+0.5	5.27b	1.01ab
Pendimethalin+prometryne	2.0+1.0	5.08b	1.41a-d
Alachlor+terbutryne	1.0+0.5	6.30b	1.10a-c
Alachlor+terbutryne	2.0+1.0	5.72b	1.84a-d
Alachlor+prometryne	1.0+0.5	6.17b	1.05ab
Alachlor+prometryne	2.0+1.0	5.63b	2.49d
Weeded check at 3, 6&9 WAS	-	1.07a	0.67a
Untreated control	-	10.00c	2.23bcd
SE (±)		0.700 *	0.381 *
Interaction			
Varietyx xweed control		NS	NS

+ All the herbicide treated plots were supplementarily weeded at 6 WAS.
1 Weed cover score was taken using a scale of 0 to 10, where 0 represented no weed cover and 10 represented completed weed cover.
2 Weeks after sowing.
3 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT)
NS, * = Not significant, significant at 5% level of probability (DMRT)

Table 36 Effects of variety and weed control treatments on weed cover and weed dry matter production in okra at Kadawa in 1985 dry season.

Treatments		Weed Cover Score [1] at 6 WAS [2]	9 WAS	Weed dry matter at harvest (t/ha)
Variety				
V35		4.34	6.28	3.29
TAE-38		4.31	6.48	3.59
SE (±)		0.143	0.164	0.223
		NS	NS	NS
Weed control	Rate (kg a.i/ha)			
Metolachlor+terbutryne	2.0+1.0	5.77g [3]	9.67g	3.21ab
"	2.0+1.0fb [4] 1.0+0.5	2.30ab	4.23b	2.31a
"	2.0+1.0fb SHW [5]	4.37d-g	2.52a	4.73b
"	1.0+0.5fb 1.0+0.5	3.72cde	7.92def	2.77ab
Metolachlor+prometryne	2.0+1.0	4.93fg	9.53fg	2.75ab
"	2.0+1.0fb 1.0+0.5	2.50abc	4.37b	33.91ab
"	2.0+1.0fb SHW	3.30bcd	2.30a	3.09b
"	1.0+0.5fb 1.0+0.5	4.17def	7.95def	2.89ab
Pendimethalin+terbutryne	2.0+1.0	7.38h	10.00g	3.21ab
"	2.0+1.0fb 1.0+0.5	3.12a-d	6.80cd	4.06ab
"	2.0+1.0fb SHW	5.37fg	4.08b	3.86ab
"	1.0+0.5fb 1.0+0.5	3.80cde	7.28de	2.24a
Pendimethalin+terbutryne	2.0+1.0	5.30fg	9.58fg	3.82ab
"	2.0+1.0fb 1.0+0.5	2.48abc	5.43 bc	4.13ab
"	2.0+1.0fb SHW	3.50cde	2.63a	4.67b
"	1.0+0.5fb 1.0+0.5	4.23def	8.68efg	3.61ab
Weeded check at 3,6&9 WAS	-	1.87a	1.83a	3.53ab
Untreated control	-	10.00g	10.00j	4.14ab
SE (±)		0.434	0.491	0.660
		*	*	*
Interaction				
Variety x weed control		NS	NS	NS

1 Weed cover score was taken using a scale of 0 to 10, where 0 represented no weed cover and 10 represented complete weed cover.

2 Weeks after sowing.

3 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

4 Followed by s post-emergence application of herbicide at 3 WAS.

5 Supplementarily hoe-weeded at 6 WAS.

NS, * = Not significant, significant at 5% level of probability.

Table 37 Effects of variety and weed control treatments on weed cover and weed dry matter production in okra at Samaru in 1984 wet season.

Treatments		Weed cover score[1] at 6 WAS[2]	Weed cover score[1] at 9 WAS	Weed dry matter at 6WAS (t/ha)
Variety				
V35		3.82	4.07	0.89
TAE- 38		3.94	4.30	0.78
S E (±)		0.171	0.17	0.08
		NS	NS	NS
Weed control	Rate (kg a.i/ha)			
Metolachlor+terbutryne	2.0+1.0	4.83def[3]	7.25i	1.07bc
"	2.0+1.0fb[4]1.0+0.5	1.00a	2.25a-d	0.20a
"	2.0+1.0fb SHW[5]	4.50def	2.00abc	1.21cd
"	1.0+0.5fb 1.0+0.5	2.00abc	3.33b-f	0.69abc
Metolachlor+prometryne	2.0+1.0	2.67abc	4.17ef	0.38ab
"	2.0+1.0fb 1.0+0.5	0.92a	2.17abc	0.44abc
"	2.0+1.0fb SHW	3.58cde	1.75ab	0.61abc
"	1.0+0.5fb 1.0+0.5	1.92abc	3.67c-g	0.44abc
Pendimethalin+terbutryne	2.0+1.0	6.00fg	7.67i	1.09bc
"	2.0+1.0fb 1.0+0.5	3.08cd	3.92d-g	0.55abc
"	2.0+1.0fb SHW	6.33g	2.50a-e	1.06bc
"	1.0+0.5fb 1.0+0.5	3.25cd	2.58g	0.99bc
Pendimethalin+prometryne	2.0+1.0±	5.17fg	6.58hi	1.20cd
"	2.0+1.0fb 1.0+0.5	2.67bc	3.92d-g	0.55abc[2]
"	2.0+1.0fb SHW	6.17fb	2.33a-d	1.20cd
"	1.0+0.5fb 1.0+0.5	3.50cde	5.33gh	0.39ab
Weeded check at 3,6&9 WAS	-	2.50abc	1.58a	0.18a
Untreated control	-	9.67h	9.92j	2.66d
SE (±)		0.523	0.511	0.232
		*	*	*
Interaction				
Variety x weed control		NS	NS	NS

1 Weed cover score was taken using a scale of 0 to 10, where 0 represented no weed cover and 10 represented completed weed cover.

2 Weeks after sowing.

3 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

4 Followed by post-emergence application of herbicide at 3 WAS.

5 Supplementarily hoe-weeded at 6 WAS.

NS, * = Not significant, significant at 5% level of probability.

Table 38 Effects of variety and weed control treatments on weed cover and weed dry matter production in okra at Samaru in 1985 wet season.

Treatments		Weed cover score [1] at 6 WAS [2]	Weed cover score [1] at 9 WAS	Weed dry matter at harvest (t/ha)
Variety				
V35		3.27	5.30b [3]	1.82
TAE-38		3.27	6.01a	1.91
SE (±)		0.134	0.244±	0.091
		NS	*	NS
Weed control	Rate (kg a.i/ha)			
Metolachlor+terbutryne	2.0+1.0	2.42ab	6.08bc	1.26a
"	2.0+1.0fb [4] 1.0+0.5	2.08a	6.42bc	1.58ab
"	2.0+1.0fb SHW [5]	2.58abc	2.17a	1.53ab
"	1.0+0.5fb 1.0+0.5	2.33ab	5.67b	1.80abc
Metolachlor+prometryne	2.0+1.0	2.75a-d	6.50bc	1.78abc
"	2.0+1.0fb 1.0+0.5	2.33ab	5.92b	1.66abc
"	2.0+1.0fb SHW	2.75a-d	2.08a	1.64ab
"	1.0+0.5fb 1.0+0.5	2.08a	5.92b	1.70abc
Pendimethalin+terbutryne	2.0+1.0	3.50bcd	8.50cd	2.21bc
"	2.0+1.0fb 1.0+0.5	3.58bcd	8.58cd	2.21bc
"	2.0+1.0fb SHW	3.92cd	2.50a	2.56c
"	1.0+0.5fb 1.0+0.5	3.08a-d	6.17bcd	1.48ab
Pendimethalin+terbutryne	2.0+1.0	3.50bcd	6.00b	2.24bc
"	2.0+1.0fb 1.0+0.5	2.75a-d	6.92bc	2.27bc
"	2.0+1.0fb SHW	4.00d	2.92a	1.95abc
"	1.0+0.5fb 1.0+0.5	3.83cd	6.75bc	1.78abc
Weeded check at 3,6&9 WAS	--	3.58bcd	12.67a	2.38bc
Untreated control	--	7.75e	10.00d	2.10abc
SE (±)		0.393	0.711	0.264
		*	*	*
Interaction				
Variety x weed control		NS	NS	NS

1 Weed cover score taken using a scale of 0 to 10, where 0 represented no weed cover and q0 10 represented complete weed cover.
2 Weeks after sowing
3 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT).
4 Followed by post-emergence herbicide application at 3 WAS.
5 Supplementarily hoe-weeded at 6 WAS.
NS , * = Not significant, significant at 5% level of probability.

prometryne at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding and pendimethalin plus terbutryne at 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha resulted in lower weed dry matter production than the highest obtained with pendimethalin plus terbutryne at 2.0 + 1.0 kg a.i./ha fb SHW (Table 38).

4.2.3 Crop stand count

Variety of okra only differed significantly in per cent stand count at harvest at Kadawa in 1984 dry season and at Samaru in 1985 wet season (Tables 39, 40 and 41). At Kadawa, variety V35 had significantly higher per cent stand count than TAE-38 while at Samaru variety TAE-38 was higher.

The weed control treatments had significant effect on per cent stand count of okra plants at harvest at Kadawa and Samaru in 1984 dry and wet seasons, respectively (Table 39 and 41). At Kadawa in 1984 dry season, all the herbicide treatments except pendimethalin plus prometryne at 1.0 + 0.5 kg a.i./ha resulted in significantly lower stand count compared with hoe-weeded and untreated controls. The least counts were obtained with mixtures of alachlor with terbutryne and prometryne and pendimethalin plus terbutryne, all at 2.0 + 1.0 kg a.i./ha. Among the herbicide treatments, mixtures of terbutryne with metolachlor and diphenamid at 2.0 + 1.0 kg and 1.0 + 0.5 kg a.i./ha respectively, pendimethalin plus prometryne at 2.0 + 1.0

Table 39 Effects of variety and weed control treatments on per cent stand count at harvest of okra at Kadawa in 1984 dry season.

Treatments		Per cent stand count at harvest
Variety		
V35		73.28a[1]
TAE-38		51.86b
SE (±)		2.578 *
Weed control[+]	Rate (kg a.i./ha)	
Metolachlor+terbutryne	1.0+0.5	59.49cde
Metolachlor+terbutryne	2.0+1.0	76.77bcd
Metolachlor+prometryne	1.0+0.5	42.14de
Metolachlor+prometryne	2.0+1.0	60.34cde
Diphenamid+terbutryne	1.0+0.5	69.41bc
Diphenamid+terbutryne	2.0+1.0	47.10cde
Diphenamid+prometryne	1.0+0.5	68.57bc
Diphenamid+prometryne	2.0+1.0	58.65cde
Pendimethalin+terbutryne	1.0+0.5	54.54cde
Pendimethalin+terbutryne	2.0+1.0	38.03e
Pendimethalin+prometryne	1.0+0.5	91.72ab
Pendimethalin+prometryne	2.0+1.0	70.25bc
Alachlor+terbutryne	1.0+0.5	70.25bc
Alachlor+terbutryne	2.0+1.0	40.51e
Alachlor+prometryne	1.0+0.5	49.58cde
Alachlor+prometryne	2.0+1.0	38.03e
Weedad check at 3, 6 & 9 WAS[2]	-	100.00a
Untreated control	-	100.00a
SE (±)		7.784
Interaction		
Variety x weed control		NS

+ All the herbicide treated plots were supplementarily weeded at 6 WAS.

1 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT).

2 Weeks after sowing

NS, * = Not significant, significant at 5% level of probability.

Table 40 Effects of variety and weed control treatments on per cent stand count at harvest of okra at Kadawa in 1985 dry season.

Treatments		Per cent stand count at harvest
Variety		
V35		87.20
TAE-38		86.40
SE (±)		1.650 NS
Weed control	Rate (kg a.i./ha)	
Metolachlor+terbutryne	2.0+1.0	84.14
"	2.0+1.0fb[1] 1.0+0.5	75.85
"	2.0+1.0fb SHW[2]	92.50
"	1.0+0.5fb 1.0+0.5	81.65
Metolachlor+prometryne	2.0+1.0	80.85
"	2.0+1.0fb 1.0+0.5	95.85
"	2.0+1.0fb SHW	94.15
"	1.0+0.5fb 1.0+0.5	86.65
Pendimethalin+terbutryne	2.0+1.0	86.65
"	2.0+1.0fb 1.0+0.5	90.00
"	2.0+1.0fb SHW	87.50
"	1.0+0.5fb 1.0+0.5	88.35
Pendimethalin+prometryne	2.0+1.0	87.50
"	2.0+1.0fb 1.0+0.5	80.85
"	2.0+1.0fb SHW	87.50
"	1.0+0.5fb 1.0+0.5	86.65
Weeded check at 3, 6 & 9 WAS[3]	-	95.85
Untreated control	-	80.00
SE (±)		4.900 NS
Interaction		
Variety x weed control		NS

1 Followed by post-emergence herbicide application at 3 WAS.

2 Supplementarily hoe-weeded at 6 WAS

3 Weeks after sowing

NS = not significant

Table 41 Effects of variety and weed control treatments on percent stand count at harvest of okra at Samaru in 1984 and 1985 wet seasons.

Treatments		Per cent stand count at harvest	
		1984	1985
Variety			
V35		77.00	80.85b
TAE-48		76.20	87.20a
SE (±)		2.200 NS	2.202 *
Weed control	Rate (kg a.i/ha)		
Metolachlor+terbutryne	2.0+1.0	91.11abc[1]	79.15
"	2.0+1.0fb[2] 1.0+0.5	91.11abc	66.65
"	2.0+1.0fb SHW[3]	96.77ab	88.35
"	1.0+0.5fb 1.0+0.5	98.37a	80.00
Metolachlor+prometryne	2.0+1.0	85.49abc	83.35
"	2.0+1.0fb 1.0+0.5	79,00bcd	80.00
"	2.0+1.0fb SHW	92.76abc	86.65
"	1.0+0.5fb 1.0+0.5	91.93abc	80.00
Pendimethalin+terbutryne	2.0+1.0	81.43cd	86.65
"	2.0+1.0fb 1.0+0.5	87.91bcd	80.85
"	2.0+1.0fb SHW	86.27cde	86.65
"	1.0+0.5fb 1.0+0.5	83.85bcd	80.00
Pendimethalin+terbutryne	2.0+1.0	78.24de	99.15
"	2.0+1.0fb 1.0+0.5	75.82ef	85.85
"	2.0+1.0fb SHW	67.74f	98.35
"	1.0+0.5fb 1.0+0.5	97.60abc	77.50
Weeded check at 3,6&9 WAS[4]	-	100.00a	93.35
Untreated control	-	94.35abc	81.65
SE (±)		6.169 *	6.387 NS
Interaction			
Variety x weed control		NS	NS

1 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT)
2 Followed by post-emergence application at 3 WAS.
3 Supplementarily hoe-weeded at 6 WAS.
4 Weeks after sowing.
NS, * = Not significant, significant at 5% level of probability.

kg a.i./ha and alachlor plus terbutryne at 1.0 + 0.5 kg a. i./ha had comparable per cent stand count to the highest obtained with pendimethalin plus prometryne at 1.0 + 0.5 kg a.i./ha. Significant depression in stand count was caused by the high rate of alachlor plus terbutryne compared with the low rate.

At Samaru in 1984 wet season, all treatments of pendimethalin plus terbutryne, pendimethalin plus prometryne at 2.0 + 1.0 kg a.i./ha, either alone, followed by half the rate 3 weeks later or supplementary hoe-weeding 6 weeks later and metolachlor plus prometryne at 2.0 + 1.0 followed by 1.0 + 0.5 kg a.i./ha resulted in significantly lower stand count compared with the hoe-weeded and untreated controls (Table 41). Treatments containing pre-emergence application of prometryne with pendimethalin at 1.0 + 2.0 kg a. i./ha had significantly lower stand counts compared with the corresponding treatments of mixture of metolachlor with prometryne.

4.2.4 Crop vigour score

As shown in tables 42 and 43, variety V35 was apparently more vigorous than TAE-38 at 6 WAS at Kadawa in 1984 dry season and at Samaru in 1984 wet season.

The weed control treatments had significant affect on crop vigour score at 6 and 9 WAS in all the treatments (Tables 42 to 45). At 6 WAS, none of the herbicid treatments resulted in crop vigour score comparable to the

Table 42 Effects of variety and weed control treatments on vigour score and plant height of okra at Kadawa in 1984 dry season.

Treatments		Crop vigour score[1] at		Plant height (cm) at harvest
		6 WAS[2]	9 WAS	
Variety				
V35		5.72	4.69	70.80
TAE-38		5.69	5.26	76.30
SE (±)		0.190 NS	0.276 NS	2.970 NS
Weed control[+]	Rate (kg a.i/ha)			
Metolachlor+terbutryne	1.0+0.5	6.20bc[3]	4.52b	81.10abc
Metolachlor+terbutryne	2.0+1.0	6.48bc	5.53ab	69.00bc
Metolachlor+prometryne	1.0+0.5	5.30bc	5.13b	69.90bc
Metolachlor+prometryne	2.0+1.0	6.83bc	6.18ab	78.60abc
Diphenamid+terbutryne	1.0+0.5	6.38bc	4.18b	62.80c
Diphenamid+terbutryne	2.0+1.0	4.82c	4.83b	65.30bc
Diphenamid+prometryne	1.0+0.5	4.68c	4.05b	71.10bc
Diphenamid+prometryne	2.0+1.0	6.48bc	5.58ab	71.50bc
Pendimethalin+terbutryne	1.0+0.5	4.57c	4.58b	62.50bc
Pendimethalin+terbutryne	2.0+1.0	4.73c	4.08b	62.40c
Pendimethalin+prometryne	1.0+0.5	6.88b	5.43ab	75.00bc
Pendimethalin+prometryne	2.0+1.0	5.83bc	5.95ab	94.80abc
Alachlor+terbutryne	1.0+0.5	5.85bc	5.60ab	83.50abc
Alachlor+terbutryne	2.0+1.0	5.22bc	4.42b	72.90bc
Alachlor+prometryne	2.0+1.0	5.50bc	5.83ab	72.40bc
Alachlor+prometryne	2.0+1.0	5.83bc	5.08b	86.60abc
Weeded check at 3,6&9 WAS	--	9.17a	8.03a	108.80a
Untreated control	-	1.98d	0.47c	34.90d
SE (±)		*	*	*
Interaction				
Variety x weed control		NS	NS	NS

+ All the herbicide treated plots were supplementarily weeded at 6 WAS.
1 Crop vigour score taken using a scale of 0 to 10, where 0 represented dead plant and 10 represented vigorous plant.
2 Weeks after sowing.
3 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).
NS , * = Not significant, significant at 5% level of probability.

Table 43 Effects of variety and weed control treatments on vigour scores of okra at Kadawa in 1985 dry season.

Treatments		Crop vigour score[1] at 6 WAS[2]	9 WAS
Variety			
V35		4.09a[3]	3.26
TAE-38		3.53b	3.11
SE (±)		0.127 *	0.126 *
Weed control	Rate (kg a.i/ha)		
Metolachlor+terbutryne	2.0+1.0	4.13bcd	2.20def
"	2.0+1.0fb[4] 1.0+0.5	2.28g	2.47d
"	2.0+10fb SHW[5]	4.43bc	6.17b
"	1.0+0.5fb 1.0+0.5	3.00d-g	1.45ef
Metolachlor+prometryne	2.0+1.0	4.03b-e	2.47d
"	2.0+1.0fb 1.0+0.5	4.07bcd	2.48c
"	2.0+1.0fb SHW	5.13b	6.07b
"	1.0+0.5fb 1.0+0.5	3.42c-g	2.42de
Pendimethalin+terbutryne	2.0+1.0	3.58c-f	1.38ef
"	2.0+1.0fb 1.0+0.5	2.75efg	1.80def
"	2.0+1.0fb SHW	3.47c-g	4.28c
"	1.0+0.5fb 1.0+0.5	2.87d-g	1.80def
Pendimethalin+prometryne	2.0+1.0	3.95b-e	2.37de
"	2.0+0.5fb 1.0+0.5	2.55fg	1.28ef
"	2.0+1.0fb SHW	4.67bc	5.78b
"	1.0+0.5fb 1.0+0.5	3.97b-e	1.80def
Weeded check at 3,6&9 WAS	-	7.53a	7.80a
Untreated control	-	2.67fg	1.00f
SE (±)		0.382	0.381
Interaction			
Variety x weed control		NS	NS

1 Crop vigour score taken using a sacle of 0 to 10, where 0 represented dead plant and 10 represented vigorous crop.

2 Weeks after sowing.

3 Means followed by the same letter(s) within the same column or ytreatment are not significantly different at 5% level of probability (DMRT).

4 Followed by post-emergence herbicide application at 4 3 WAS.

5 Supplementarily hoe-weeded at 6 WAS.

NS, * = Not significant, significant 5% level of probability.

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hoe-weeded control at Kadawa in 1984 and 1985 dry seasons (Tables 42 and 43). However, crop treated with herbicides had higher vigour scores than the untreated control in 1984 while mixtures of metolachlor with terbutryne and prometryne each at 2.0 + 1.0 kg a.i./ha, pendimethalin plus prometryne at 2.0 + 1.0 kg a.i./ha and 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha were higher in 1985 at the same location. At 9 WAS, crop treated with mixtures of metolachlor with terbutryne and prometryne and diphenamid plus prometryne each at 2.0 + 1.0 kg a.i./ha, pendimethalin plus prometryne at both rates and alachlor with terbutryne and prometryne,[2] each at 1.0 + 0.5 kg a.i./ha had vigour scores that were comparable to that of the hoe-weeded control in 1984 dry season (Table 42). However, at the same location in 1985 dry season, none of the herbicide treatments had comparable crop vigour score to the hoe-weeded control at 9 WAS (Table 43).

At Samaru in 1984 wet season, crop vigour score with all treatments containing metolachlor plus terbutryne at 2.0 + 1.0 kg a.i./ha and those of metolachlor plus prometryne did not differ significantly from that of the hoe-weeded control at 6 WAS (Table 44). Similarly, at the same location in 1985, okra vigour score at 6 WAS on all the plots with supplementary hoe-weeding and those sprayed pre-emergence with metolachlor-based mixtures as well as pendimethalin plus prometryne at 2.0 + 1.0 kg a.i./ha were comparable to those of the hoe-weeded control alone

Table 44 Effects of variety and weed control treatments on vigour scores of okra at Samaru in 1984 wet season.

Treatments		Crop vigour score[1] at 6 WAS[2]	9 WAS
Variety			
V35		3.00a[3]	3.29
TAE-38		2.44b	3.05
SE (±)		0.170	0.194
		*	*
Weed control	Rate (kg a.i/ha)		
Metolachlor+terbutryne	2.0+1.0	4.83ab	4.33bcd
"	2.0+1.0fb[4] 1.0+0.5	4.50ab	5.00abc
"	2.0+1.0fb SHW[5]	4.75ab	6.42a
"	1.0+0.5fb 1.0+0.5	3.17bc	3.33c-f
Metolachlor+prometryne	2.0+1.0	3.83abc	3.67cde
"	2.0+1.0fb 1.0+0.5	3.58abc	4.33bcd
"	2.0+1.0fb SHW	3.50abc	5.75ab
"	1.0+0.5fb 1.0+0.5	5.17a	4.83abc
Pendimethalin+terbutryne	2.0+1.0	1.17d	1.00g
"	2.0+1.0fb 1.0+0.5	1.08d	1.50fh
"	2.0+1.0fb SHW	1.17d	2.50fg
"	1.0+0.5fb 1.0+0.5	1.25d	1.17g
Pendimethalin+prometryne	2.0+1.0	1.08d	0.92g
"	2.0+1.0fb 1.0+0.5	1.08d	1.00g
"	2.0+1.0fb SHW	0.83d	1.92efg
"	1.0+0.5fb 1.0+0.5	1.00d	1.42fg
Weeded check at 3,6&9 WAS	-	4.67ab	6.33a
Untreated control	-	2.33cd	1.58fg
SE (±)		0.511	0.581
Interaction			
Variety x weed control		NS	NS

1 Crop vigour score taken using a scale of 0 to 10, where 0 represented dead plant and 10 represented vigorous crop.
2 Weeks after sowing.
3 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT).
4 Followed by post-emergence herbicide application at 3 WAS.
5 Supplementarily hoe-weeded at 6 WAS.
NS, * = Not significant, significant 5 at 5% level of probability.

Table 45 Effects of variety and weed control treatments on vigour scores of okra at Samaru in 1985 wet season.

Treatments		Crop vigour score[1] at 6 WAS[2]	9 WAS
Variety[3]			
V35		5.19	4.70
TAE-38		5.47	4.93
SE (±)		0.141 NS	0.169 NS
Weed control	Rate (kg a.i/ha)		
Metolachlor+terbutryne	2.0+1.0	5.67abc[3]	6.50abc
"	2.0+1.0fb[4]1.0+0.5	4.75cde	4.42def
"	2.0+1.0fb SHW[5]	5.83abc	7.00ab
"	1.0+0.5fb 1.0+0.5	5.00cde	4.67def
Metolachlor+prometryne	2.0+1.0	5.58abc	3.83efg
"	2.0+1.0fb 1.0+0.5	4.17de	2.33g
"	2.0+1.0fb SHW	6.50ab	5.83bc
"	1.0+0.5fb 1.0+0.5	6.17abc	6.75ab
Pendimethalin+terbutryne	2.0+1.0	4.92cde	3.58efg
"	2.0+1.0fb 1.0+0.5	4.17de	2.33g
"	2.0+1.0fb SHW	5.83abc	6.42abc
"	1.0+0.5fb 1.0+0.5	4.08e	3.33efg
Pendimethalin+prometryne	2.0+1.0	5.50a-d	3.83efg
"	2.0+1.0fb 1.0+0.5	4.17de	3.00fg
"	2.0+1.0fb SHW	6.17abc	7.08ab
"	1.0+0.5fb 1.0+0.5	4.92cde	3.42efg
Weeded check at 3, 6&9 WAS	-	6.75a	7.67a
Untreated control	-	4.92cde	2.17g
SE (±)		0*422 *	0.508 *
Interaction			
Variety x weed control		*	NS

1 Crop vigour score taken using a scale of 0 to 10, where 0 represented dead plant and 10 represented vigorous crop.
2 Weeks after sowing
3 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT)
4 Followed by post-emergence herbicide application at 3 WAS.
5 Supplementarily hoe-weeded at 6 WAS.
NS, * = Not significant, significant at 5% level of probability.

Table 46 Interaction of variety and weed control treatments on vigour score of okra at Samaru in 1985 wet season.

Treatments Weed control	Rate (kg a.i./ha)	Vigour score at 6WAS[1] V35	 TAE-38
Metolachlor+terbutryne	2.0+1.0	5.83a-e[2]	5.50a-f
"	2.0+1.0fb[3] 1.0+0.5	4.67b-f	4.83b-f
"	2.0+1.0fb SHW[4]	6.00a-e	5.17a-f
"	1.0+0.5fb 1.0+0.5	5.33a-f	4.67b-f
Metolachlor+prometryne	2.0+1.0	5.00b-f	6.17a-d
"	2.0+1.0fb 1.0+0.5	4.33c-f	6.17a-d
"	2.0+1.0fb SHW	4.83b-f	6.27a-d
"	1.0+0.5fb 1.0+0.5	5.67a-f	6.67ab
Pendimethalin+terbutryne	2.0+1.0	5.17a-f	6.67ab
"	2.0+1.0fb 1.0+0.5	4.33c-d	4.00ef
"	2.0+1.0fb SHW	5.83a-e±	5.83a-e
"	1.0+0.5fb 1.0+0.5	3.67f	4.50c-f
Pendimethalin+prometryne	2.0+1.0	5.67a-f	5.33a-f
"	2.0+1.0fb 1.0+0.5	3.67f	4.67b-f
"	2.0+1.0fb SHW	6.67ab	5.67a-f
"	1.0+0.5fb 1.0+0.5	5.33a-f	4.50e-f
Weeded check at 3,6&9 WAS	-	7.17a	6.33a-c
Untreated control	-	4.17def	5.67a-f
SE (±)		0.596	

1 Crop vigour score taken using a scale of 0 to 10, where 0 represented dead plant and 10 represented vigonous crop.

2 Means followed by the same letter(s) within rows and column. are not significantly different at 5% level of probability (DMRT).

3 Followed by post-emergence application of herbicide at 3 WAS.

4 Supplementarily hoe-weeded at 6 WAS.

(Table 45). At 9 WAS, only the crop vigour scores of the plants treated with metolachlor plus terbutryne at 2.0 + 1.0 kg a.i./ha and followed by either half the rate at 3 weeks later or supplementary hoe-weeding as well as metolachlor plus prometryne at 2.0 +1.0 followed by supplementary hoe-weeding and 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha were comparable to that of the hoe-weeded control. In 1985, crop vigour of plants on plots with supplementary hoe-weeding except those treated with metolachlor plus prometryne at 1.0 + 0.5 fb 1.0 + 0.5 kg a.i./ha were comparable to those of the hoe-weeded control.

There was significant interaction between variety of okra and weed control treatments on crop vigour score at 6 WAS at Samaru in 1985 wet season (Table 46). However higher vigour was recorded in TAE-38 than V35 in all plots sprayed with metolachlor plus prometryne.

4.2.5 Leaf production

In all the experiments, varieties of okra did not differ significantly in the number of leaves produced per square metre (Tables 47, 48 and 49).

The weed control treatments significantly affected the number of leaves produced per square metre in okra at

Table 47 Effects of variety and weed control treatments on number of levels per square metre in okra at Kadawa in 1985 dry season.

Treatments		Number of leaves/m² at 6 WAS[1]	9 WAS
Variety			
V35		13.78	17.99
TAE-38		14.10	20.36
SE (±)		0.415	0.948
Weed control	Rate (kg a.i/ha)		
Metolachlor+terbutryne	2.0+1.0	13.84	17.78cde[2]
Metolachlor+terbutryne	2.0+1.0fb 1.0+0.5	12.36	13.84de
"	2.0+1.0fb SHW[3]	14.31	27.64ab
"	1.0+0.5fb 1.0+0.5	12.83	15.79cde
Metolachlor+prometryne	2.0+1.0	13.84	12.83e
"	2.0+1.0fb 1.0+0.5	13.33	25.19abc
"	2.0+1.0fb SHW	16.30	23.20bcd
"	1.0+0.5fb 1.0+0.5	15.32	15.32de
Pendimethalin+terbutryne	2.0+1.0	13.33	12.83e
"	2.0+1.0fb 1.0+0.5	12.36	18.76b-e
"	2.0+1.0fb SHW	12.83	26.67ab
"	1.0+0.5fb 1.0+0.5	11.85	17.27cde
Pendimethalin+prometryne	2.0+1.0	15.79	14.31de
"	2.0+1.0fb 1.0+0.5	14.31	18.28b-e
"	2.0+1.0fb SHW	15.79	23.20bcd
"	1.0+0.5fb 1.0+0.5	13.33	16.30cde
Weeded check at 3,6&9 WAS	-	16.80	34.07a
Untreated control	-	12.36	10.87e
SE (±)	-	1.215	2.844
		NS	*
Interaction			
Variety x weed control		NS	NS

1 Weeks after sowing.
2 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT).
3 Followed by post-emergence herbicide application at 3 WAS.
4 Supplementarily hoe-weeded at 6 WAS.
NS, * 0 Not significant, significant at 5% level of probability

Table 48 Effects of variety and weed control treatments on number of leaves per square metre in okra at Samaru in 1984 wet season.

Treatments		Number of leaves/m^2 at 9 WAS[1]	12 WAS
Variety			
V35		21.16	20.98
TAE-38		20.39	21.36
SE (±)		0.859	1.541
		NS	NS
Weed control	Rate (kg a.i/ha)		
Metolachlor+terbutryne	2.0+1.0	23.64bcd[2]	24.47a-e
"	2.0+1.0fb[3] 1.0+0.5	24.30bcd	22.43b-e
"	2.0+1.0fb SHW[4]	25.19abc	31.11a-d
"	1.0+0.5fb 1.0+0.5	20.62b-e	15.70de
Metolachlor+terbutryne	2.0+1.0	23.35bcd	19.44b-e
"	2.0+1.0fb 1.0+0.5	28.83ab	34.76ab
"	2.0+1.0fb SHW	28.83ab	33.39abc
"	1.0+1.0fb 1.0+0.5	24.98bc	22.28b-e
Pendimethalin+terbutryne	2.0+1.0	12.98e	11.59e
"	2.0+1.0fb 1.0+0.5	15.85de	16.00e
"	2.0+1.0fb SHW	20.21b-e	25.60a-e
"	1.0+0.5fb 1.0+0.5	14.28b-e	10.13e
Pendimethalin+prometryne	2.0+1.0	13.63e	13.99
"	2.0+1.0fb 1.0+0.5	14.13e	15.11e
"	2.0+1.0fb SHW	17.63cde	15.72cde
"	1.0+0.5fb 1.0+0.5	18.31cde	14.67ed
Weeded check at 3,6&9 WAS	-	33.93a	38.87a
Untreated control	-	13.48e	13.90e
SE (±)		2.607	4.593
		*	*
Interaction			
Variety x weed control		NS	NS

1 Weeks after sowing.
2 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT).
3 Followed by post-emergence application of herbicide at 3 WAS.
4 Supplementarily hoe-weeded at 6 WAS.
NS,* = Not significant, significant at 5% level of probability.

Table 49 Effects of variety and weed control treatments on number of leaves per square metre in okra at Samaru in 1985 wet season.

Treatments		Number of leaves/m² 9 WAS[1]	12 WAS
Variety			
V35		15.64	13.57
TAE-38		16.24	13.54
SE (±)		0.563 NS	0.741 NS
Weed control	Rate (kg a.i/ha)		
Metolachlor+terbutres	2.0+1.0	16.29	23.20a[2]
"	2.0+1.0fb[3] 1.0+0.5	15.31	13.84bc
"	2.0+1.0fb SHW[4]	16.80	14.07bc
"	1.0+0.5fb 1.0+0.5	16.80	15.05bc
Metolachlor+prometryne	2.0+1.0	12.36	17.27ab
"	2.0+1.0fb 1.0+0.5	14.58	14.31bc
"	2.0+1.0fb SHW	17.54	13.33bc
"	1.0+0.5fb 1.0+0.5	20.23	13.84bc
Pendimethalin+terbutryne	2.0+1.0	12.36	8.65c
"	2.0+1.0fb 1.0+0.5	17.78	13.33bc
"	1.0+1.0fb SHW	17.04	11.35bc[2]
"	1.0+0.5fb 1.0+0.5	15.56	12.59bc
Pendimethalin+prometryne	2.0+1.0	17.48	12.09bc
"	2.0+1.0fb 1.0+0.5	14.58	11.61bc
"	2.0+1.0fb SHW	16.80	11.85bc
"	1.0+0.5fb 1.0+0.5	16.80	11.32bc
Weeded check at 3,6&9 WAS	-	18.76	15.94abc
Untreated control	-	12.59	10.37bc
SE (±)		1.719 NS	2.193 *
Interaction			
Variety x weed control		NS	NS

1 Weeks after sowing.
2 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT).
3 Followed by post-emergence application at 3 WAS.
4 Supplementarily hoe-weeded at 6 WAS.
NS, * = Not significant, significant at 5% level of probability.

9 WAS in 1985 dry season at Kadawa, 9 and 12 WAS in 1984 and at 12 WAS in 1985 wet seasons at Samaru. In 1985 dry season at 9 WAS, the crop treated with mixtures of terbutryne with metolachlor and pendimethalin, each at 1.0 + 2.0 kg a.i./ha followed by supplementary hoe-weeding and metolachlor plus prometryne at 2.0 + 1.0 followed by 1.0+ 0.5 kg a.i./ha produced similar number of leaves/m^2 to those of the hoe-weeded control but higher than those of the untreated check (Table 47). In addition to those herbicide treatments indicated, mixtures of prometryne with metolachlor and pendimethalin, each at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding resulted in higher number of leaves per square metre than the untreated check.

At Samaru in 1984 wet season, the number of leaves/m^2 of crop treated with mixtures of metolachlor with terbutryne and prometryne, each at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding and metolachlor plus prometryne at 2.0 + 1.0 followed by 1.0 + 0.5 kg a.i./ha did not differ significantly from that of the hoe-weeded control but higher than that of the untreated check at 9 WAS. Mixtures of metolachlor with terbutryne and prometryne, each at 2.0 + 1.0 kg a.i./ha alone, metolachlor plus terbutryne at 2.0 + 1.0 followed by 1.0 + 0.5 kg a.i./ha and metolachlor plus pprometryne at 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha also resulted in significantly higher leaf number/m^2 compared with the untreated check but lower than

the hoe-weeded control (Table 48). At 12 WAS, among the herbicide treatments, mixtures of metolachlor with terbutryne and prometryne, each at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding and the same pre-emergence mixture of metolachlor with prometryne followed by half the rate at 3 weeks later resulted in comparable leaf number/m^2 to the hoe- weeded control and significantly higher than the untreated check.

In 1985, at 12 WAS, metolachlor plus terbutryne at 2.0 + 1.0 kg a.i./ha alone resulted in the highest leaf number/m^2 which was also comparable to that of the corresponding prometryne mixture and the hoe-weeded control (Table 49).

4.2.6 Plant height

Plants of variety TAE-38 were significantly taller than those of V35 at 9 WAS in 1984 and at 6 and 12 WAS in 1985 wet seasons at Samaru (Tables 50, 51 and 52).

The weed control treatments had significant effect on the okra plant height taken in all the dry season and 1984 wet season trials and at 12 WAS in 1985 wet season. In 1984 dry season, all the herbicide treatments resulted in taller plants at harvest than the untreated check (Table 42). Although all the herbicide treatments had supplementary hoe-weeding, only mixtures of prometryne with metolachlor,

Table 50 *Effects of variety and weed control treatments on okra plant height at Kadawa in 1985 dry season.*

Treatments		Plant height (cm) at 6 WAS[1]	Plant height (cm) at 9 WAS
Variety			
V35		22.39	43.30
TAE-38		21.07	41.59
SE (±)		0.579 NS	1.235 NS
Weed control	Rate (kg a.i/ha)		
Metolachlor+ terbutryne	2.0+1.0	22.33a-d[2]	55.83ab
"	2.0+1.0fb[3]1.0+0.5	18.00d	25.67g
"	2.0+1.0fb SHW[4]	24.17abc	46.83abc
"	1.0+0.5fb 1.0+0.5	19.67cd	34.67d-g
Metolachlor+prometryne	2.0+1.0	23.50a-d	52.00abc
"	2.0+1.0fb[3]1.0+0.5	17.67	31.33fg
"	2.0#1.0fb SHW	22.17a-d	32.33c-f
"	1.0+0.5fb 1.0+0.5	23.33a-d	44.67b-e
Pendimethalin+terbutryne	2.0+1.0	22.83a-d	39.50c-f
"	2.0+1.0fb 1.0+0.5	19.00cd	40.50c-f
"	2.0+1.0fb SHW	19.50cd	40.50c-f
"	1.0+0.5fb 1.0+0.5	19.33cd	33.83efg
Pendimethalin+Prometryne	2.0+1.0	22.33a-d	57.33ab
"	2.0+1.0fb 1.0+0.5	20.83bcd	34.33ab
"	2.0+1.0fb SHW	22.00a-d	41.00c-f
"	1.0+0,5fb 1.0+0.5	20.33cd	39.67c-f
Weeded check at 3,6&9 WAS	-	26.33ab	58.50a
Untreated control	-	27.33ab	45.50b-e
SE(±)		1.737 *	3.707 *
Interaction			
Variety x weed control		NS	NS

1 Weeks after sowing
2 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT)
3 Followed by post-emergence herbicide application at 3 WAS.
4 Supplementarily hoe-weeded at 6 WAS.
5 NS, * = Not significant, significant at 5% level of probability.

Table 51 Effects of variety and weed control treatments on okra plant height at Samaru in 1984 wet season.

Treatments		Plant height (cm) at 9 WAS[1]	12 WAS
Variety			
V2			
V35		39.69b[2]	69.68
TAE-38		42.27a	73.99
SE (±)		1.694 *	4.613 NS
Weed control	Rate (kg a.i/ha)		
Metolachlor+terbutryne	2.0+1.0	72.35a	88.84a-d
"	2.0+1.0fb[3]1.0+0.5	48.27cde	79.38a-e
"	2.0+1.0fb SHW	52.38bc	105.90a
"	1.0+0.5fb 1.0+0.5	44.55c-f	63.91a-e
Metolachlor+prometryne	2.0+1.0	49.40cde	80.86a-e
"	2.0+1.0fb 1.0+0.5	53.37bc	87.71a-d
"	2.0+1.0fb SHW	53.37bc	100.10a
"	1.0+0.5fb 1.0+0.5	67.80ab	95.39abc
Pendimethalin+terbutryne	2.0+1.0	33.55efg	54.05b-e
"	2.0+1.0fb 1.0+0.5	27.28g	49.41cde
"	2.0+1.0fb SHW	30.22fg	62.09a-e
"	1.0+1.0fb 1.0+0.5	22.87g	35.85e
Pendimethalin+prometryne	2.0+1.0	27.27g	43.15de
"	2.0+1.0fb 1.0+0.5	21.80g	46.30de
"	2.0+1.0fb SHW	19.73g	46.47de
"	1.0+1.0fb 1.0+0.5	34.88d-g	97.85ab
Weeded check at 3,6&9 WAS	-	54.73bc	80.20a-e
Untreated control	-	50.55bcd	68.54a-e
SE (±)		5.081 *	13.839 *
Interaction			
Variety x weed control		*	NS

1 Weeks after sowing
2 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT).
3 Followed by post-emergence herbicide application at 3 WAS.
4 Supplmentarily hoe-weeded at 6 WAS.
NS, * = Not significant, significant at 5% level of probability.

Table 52 Effects of variety and weed control treatments on okra plant height at Samaru in 1985 wet season.

Treatments		Plant height (cm) at 6 WAS[1]	9 WAS	12 WAS
Variety				
V 35		19.45b[2]	34.10	62.40b
TVE-38		22.58a	37.30	70.50a
SE (±)		0.859	1.534	2.857
		*	NS	*
Weed control	Rate (kg a.i/ha)			
Metolachlor+terbutryne	2.0+1.0	23.42	41.20	87.50a
"	2.0+1.0fb[3] 1.0+0.5	18.55	41.90	76.00abc
"	2.0+1.0fb SHW[4]	15.80	32.80	50.70cd
"	1.0+0.5fb 1.0+0.5	22.56	34.50	62.20a-d
Metolachlor+prometryne	2.0+1.0	18.21	31.70	86.40ab
"	2.0+1.0fb 1.0+0.5	22.64	39.70	68.40a-d
"	2.0+1.0fb SHW	25.19	30.30	77.20abc
"	1.0+0.5fb 1.0+0.5	21.70	36.20	67.40a-d
Pendimethalin+terbutryne	2.0+1.0	20.87	31.70	67.40a-d
"	2.0+1.0fb 1.0+0.5	18.37	35.10	45.40d
"	2.0+1.0fb SHW	22.05	30.90	70.70a-d
"	1.0+0.5fb 1.0+0.5	16.53	37.20	57.10bcd
Pendimethalin+prometryne	2.0+1.0	22.60	43.10	63.50a-d
"	2.0+1.0fb 1.0+0.5	18.19	28.30	55.20cd
"	2.0+1.0fb SHW	19.88	32.30	68.90a-d
"	1.0+0.5fb 1.0+0.5	18.26	30.70	60.90a-d
Weeded check at 3, 6&9 WAS	-	26.71	41.40	73.30a-d
Untreated control	-	26.70	43.80	55.80cd
SE(±)		2.577	4.517	8.570
		NS	NS	*
Interaction				
Variety x weed control		NS	NS	NS

1 Weeks after sowing.
2 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT).
3 Followed by post-emergence herbicide application at 3 WAS.
4 Supplementarily hoe-weeded at 6 WAS.
NS, * = Not significant, significant at 5% level of probability.

pendimethalin and alachlor, each at 1.0 + 0.5 kg a.i./ha, and mixtures of terbutryne with metolachlor and alachlor, each at 0.5 + 1.0 kg a.i./ha resulted in okra plant height comparable to that of the hoe-weeded control.

In 1985 dry season, all the herbicide mixtures at 2.0 + 1.0 kg a.i./ha alone and the same mixtures followed by supplementary hoe-weeding except pendimethalin plus terbutryne as well as metolachlor plus prometryne at 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha resulted in okra plant heights that were comparable to the tallest obtained with the untreated control (Table 50). Plant height with the untreated control was also comparable at this stage of crop growth with the above indicated treatments. Supplementary application at 1.0 + 0.5 kg a.i./ha depressed plant height significantly when metolachlor plus terbutryne was applied pre-emergence at 2.0 + 1.0 kg a.i./ha. At 9 WAS, height of okra plants treated with mixture of metolachlor with terbutryne at 2.0 + 1.0 kg a.i./ha alone and followed by supplementary hoe-weeding, mixtures of prometryne with metolachlor and pendimethalin, each at 1.0 + 2.0 kg a.i./ha were comparable to those of the hoe-weeded control. Supplementary herbicide application at 3 WAS resulted in significantly shorter okra plants when preceded by metolachlor-based mixtures and pendimethalin plus prometryne, each at 2.0 + 1.0 kg a.i./ha compared with the pre-emergence application alone. Split application of

metolachlor plus terbutryne and pendimethalin plus prometryne,each at 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha resulted in shorter plants than the single pre-emergence application at 2.0 + 1.0 kg a.i./ha.

In the 1984 wet season at Samaru, metolachlor plus terbutryne at 2.0 + 1.0 kg a.i. alone resulted in the tallest plants at 9 WAS (Table 51). Among the weed control treatments, only plots treated with metolachlor plus prometryne at 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha had plant height comparable to this treatment. All the metolachlor-based mixtures however resulted in plant height comparable to the hoe-weeded control while all the pendimethalin-based treated plots except those of pendimethalin plus prometryne at 1.0 + 0.5 followed by 1. 0 + 0.5 kg a.i./ha had plants that were significantly shorter than the hoe-weeded control and the untreated check.

At 12 WAS, the plots treated with metolachlor-based mixtures followed by supplementary hoe-weeding had the tallest plants. At this stage, plants on plots with metolachlor-based mixtures, pendimethalin plus terbutryne at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding and pendimethalin plus prometryne at 1.0 + 0.5 followed by 1.0 +0.5 kg a.i./ha did not differ significantly from those of the tallest plants and the hoe-weeded control.

At 12 WAS in the 1985 wet season, the tallest plants were obtained on plots treated with metolachlor plus terbutryne at 2.0 + 1.0 kg a.i./ha while the shortest occurred on plots treated with pendimethalin plus terbutryne and metolachlor plus terbutryne each at 2.0 + 1.0 kg followed by 1.0 + 0.5 kg a.i./ha (Table 52). Metolachlor plus prometryne at 2.0 + 1.0 kg a.i./ha with and without supplementary hoe-weeding resulted in okra plant heights that were comparable to the tallest and significantly different from the shortest. Plots treated with metolachlor plus terbutryne at 2.0 + 1.0 followed by supplementary hoe-weeding, pendimethalin plus prometryne at 2.0 + 1.0 followed by 1.0+0.5 kg a. i./ha and those untreated had significantly shorter plants than the tallest obtained in the trial.

The interaction between variety and weed control treatments on plant height at 9 WAS was significant in 1984 wet season at Samaru (Table 53). In variety TAE-38, the tallest plants of okra were obtained in plots treated with mixtures of metolachlor with terbutryne at 2.0 + 1.0 kg a.i. /ha, metolachlor with prometryne at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding and at 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha. In V35, only the hoe-weeded control was comparable.

Table 53 Interaction between variety and weed control treatments on okra plant height at 6 WAS at Samaru in 1984 wet season.

Treatments Weed control	Rate (kg a.i/ha)	Plant height (cm) at 6 WAS V35	TAE-38
Metolachlor+terbutryne	2.0+1.0	59.90b-f[1]	86.80a
"	2.0+1.0fb[2] 1.0+0.5	43.33d-j	51.20c-h
"	2.0+1.0fb SHW[3]	61.27b-e	43.50d-k
"	1.0+0.5fb 1.0+0.5	36.13f-l	52.97e-l
Metolachlor+prometryne	2.0+1.0	61.24b-e	37.57e-l
"	2.0+1.0fb 1.0+0.5	41.97d-l	64.78a-d
"	2.0+1.0fb SHW	34.78f-l	72.47abc
"	1.0+0.5fb 1.0+0.5	53.00c-g	82.60ab
Pendimethalin+terbutryne	2.0+1.0	28.77g-l	38.33e-l
"	2.0+1.0fb 1.0+0.5	29.100g-l	25.47i-l
"	2.0+1.0fb SHW	25.67i-l	34.77f-l
"	1.0+0.5fb 1.0+0.5±	20.23kl	25.50i-l
Pendimethalin+prometryne	2.0+1.0	24.07jkl	30.47g-l
"	2.0+1.0fb 1.0+0.5	26.27h-l	17.331
"	2.0+1.0fb SHW	21.27jkl	18.201
"	1.0+0.5fb 1.0+0.5	33.79f-l	35.97f-l
Weed check at 3,6&9 WAS[4]	-	64.37a-d	45.10d-k
Untreated control	-	49.33c-i	51.77c-g
se (±)		7.186	

1 Means followed by the same letter(s) within rows and columns are not significantly different at 5% level of probability(DMRT).

2 Followed by post-emergence herbicide application at 3 WAS.

3 Supplementary hoe-weeded at 6 WAS.

4 Weeks after sowing.

4.2.7 Shoot dry matter production

Variety TAE-38 produced significantly higher shoot dry matter at 12 WAS than V35 at Kadawa in 1984 dry season (Table 54).

The weed control treatments significantly affected okra shoot dry matter production at 9 and 12 WAS in 1984, 6 and 9 WAS in 1985 dry seasons at Kadawa and at 6 and 12 WAS at Samaru in 1984 wet season (Tables 54, 55 and 56). In 1984 dry season, only plots treated with pendimethalin plus prometryne at 1.0 + 0.5 kg a.i./ha produced shoot dry matter at 9 WAS comparable to the hoe-weeded control although metolachlor plus terbutryne at 2.0 + 1.0 kg a.i./ha also had higher shoot dry matter production than the untreated check (Table 54). At 12 WAS, shoot dry matter production with both rates of metolachlor plus prometryne, pendimethalin plus terbutryne and prometryne as well as alachlor plus prometryne, mixtures of diphenamid with terbutryne and prometryne and metolachlor with terbutryne, each at 2.0 + 1.0 kg a.i./ha were comparable to that of the hoe-weeded control and significantly higher than that of the untreated check.

In 1985 dry season at the same location, okra shoot dry matter production at 6 WAS in plots treated with mixtures of metolachlor with terbutryne and prometryne and pendimethalin plus prometryne, each at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding as well as metolachlor plus prometryne at 2.0 + 1.0 kg a.i./ha alone were comparable to the hoe-weeded control (Table 55). However,

Table 54 Effects of variety and weed control treatments on shoot dry matter production of okra at Kadawa in 1984 dry season.

Treatments		Shoot dry matter (g/m^2)	
		9 WAS[1]	12 WAS
Variety			
V35		200.9	226.1b[2]
TAE-38		251.7	298.7a
SE (±)		18.696	22.133
Weed control[+]		NS	*
	Rate (kg a.i/ha)		
Metolachlor+terbutryne	1.0+0.5	230.2bc	224.6bc
Metolachlor+terbutryne	2.0+1.0	301.6b	368.0ab
Metolachlor+prometryne	1.0+0.5	237.0bc	252.7ab
Metolachlor+prometryne	2.0+1.0	185.2bc	284.4ab
Diphenamid+terbutryne	1.0+0.5	196.2bc	222.2bc
Diphenamid+terbutryne	2.0+1.0	188.7bc	239.1abc
Diphenamid+prometryne	1.0+0.5	138.4bc	142.2bc
Diphenamid+prometryne	2.0+1.0	275.6bc	311.1ab
Pendimethalin+terbutryne	1.0+0.5	154.7bc	345.8ab
Pendimethalin+terbutryne	2.0+1.0	163.0bc	255.7ab
Pendimethalin+prometryne	1.0+0.5	322.4ab	232.0abc
Pendimethalin+prometryne	2.0+1.0	227.3bc	366.8ab
Alachlor+terbutryne	1.0+05	178.4bc	203.0bc
Alachlor+terbutryne	2.0+1.0	179.9bc	213.9bc
Alachlor+prometryne	1.0+0.5	271.1bc	286.5ab
Alachlor+prometryne	2.0+1.0	211.9bc	349.9ab
Weeded check at 3, 6&9 WAS	-	515.0a	458.4a
Untreated control	-	94.2c	30.2c
SE(±)		56.129	66.380
Interaction		*	*
Variety x weed control		NS	NS

+ All h the herbicide treated plots were supplementarily hoe-weeded at 6 WAS.
1 Weeks after sowing
2 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT).

3NS, * 0 = Not significant, significant at 5% level of probability.

Table 55 Effects of variety and weed control treatments on shoot dry matter production in okra at Kadawa in 1985 dry season.

Treatments		Shoot dry matter (g/m²) 6 WAS[1]	9 WAS
Variety			
V35		36.27	95.70
TAE-38		33.63	102.22
SE (±)		1.985	6.933
		NS	NS
Weed control	Rate (kg a.i/ha)		
Metolachlor+terbutryne	2.0+1.0	38.52b-e[2]	107.25cd
"±	2.0+1.0fb[3] 1.0+0.5	20.24e	51.26d
"	2.0+1.0fb SHW[4]	44.44abc	179.26ab
"	1.0+0.5fb 1.0+0.5	24.21cde	59.85d
Metolachlor+prometryne	2.0+1.0	42.46a-d	102.22cd
"	2.0+1.0fb 1.0+0.5	31.11cde	105.19cd
"	2.0+1.0fb SHW	55.79ab	153.48bc
"	1.0+0.5fb 1.0+0.5	38.52b-e	85.33cd
Pendimethalin+terbutryne	2.0+1.0	32.08cde	61.63d
"	2.0+1.0fb 1.0+0.5	22.22de	66.67d
"	2.0+1.0fb SHW	22,72de	118.52bcd
"	1.0+0.5fb 1.0+0.5	20.24e	51.85d
Pendimethalin+prometryne	2.0+1.0	39.50b-e	85.93cd
"	2.0+1.0fb 1.0+0.5	27.64cde	52.74d
"	2.0+1.0fb SHW	46.90abc	150.22bc
"	1.0+0.5fb 1.0+0.5	29.13cde	73.48de
Weeded check at 3,6&9 WAS	-	60.74a	225.78a
Untreated control	-	32.59cde	49.48d
SE(±)		5.985	20.830
		*	*
Interaction			
Variety x weed control		NS	NS

1 Weeks after sowing.

2 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT),.

3 Followed by post-emergence herbicide application at 3 WAS.

4 Supplementarily hoe-weeded at 6 WAS.

NS, * = Not significant, significant at 5% level of probability.

Table 56 Effects of variety and weed control treatments on shoot dry matter production in okra at Samaru in 1984 wet season.

Treatments		Shoot dry matter (g/m²) 6 WAS[1]	9 WAS	12 WAS
Variety				
V 35		4.24	61.93	144.00
TAE-38		3.67	62.22	142.81
SE (±)		0.326	5.422	15.052
		NS	NS	NS
Weed control	Rate (kg a.i/ha)			
Metolachlor+terbutryne	2.0+1.0	6.37ab[3]	75.85	324.44a
"	2.0+1.0fb[2] 1.0+0.5	2.81cd	95.41	172.74ab
"	2.0+1.0fb SHW[4]	3.41a-d	74.07	131.85b
"	1.0+0.5fb 1.0+0.5	4.06a-d	70.22	129.78b
Metolachlor+prometryne	2.0+1.0	4.79cd	42.67	229.04ab
"	2.0+1.0fb 2.0+0.5	4.09a-d	52.74	120.59b
"	2.0+1.0fb SHW	4.95a-d	58.67	151.11b
"	1.0+0.5fb 1.0+0.5	4.89a-d	79.41	173.04ab
Pendimethalin+terbutryne	2.0+1.0	3.44a-d	48.59	104.59
"	2.0+1.0fb 1.0+0.5	1.81d	52.44	78.22b
"	2.0+1.0fb SHW	5.24abc	45.33	114.67b
"	1.0+0.5fb 1.0+0.5	3.06bcd	51.56	134.81b
Pendimethalin+prometryne	2.0+1.0	4.21a-d	59.26	104.30b
"	2.0+1.0fb 1.0+0.5	3.73a-d	35.56	99.85b
"	2.0+1.0fb SHW	4.62a-d	74.37	151.70b
"	1.0+0.5fb 1.0+0.5	2.99bcd	77.04	106.96b
Weeded check at 3,6&9 WAS	-	6.70a	81.19	161.19b
Untreated control	-	2.22cd	42.267	45.185
SE (±)		0.978	16.267	45.185
		*	NS	*
Interaction				
Variety x weed control		NS	NS	NS

1 Weeks after sowing

2 Followed by post-emergence herbicide application.

3 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT).

4 Supplementarily hoe-weeded at 6 WAS.

NS, * = Not significant, significant at 5% level of probability.

at 9 WAS, only metolachlor plus terbutryne at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding resulted in shoot dry matter comparable to the hoe-weeded control.

At Samaru, in 1984 wet season, all the herbicide treated plots except mixtures of terbutryne with metolachlor and pendimethalin at 2.0 + 1.0 followed by 1.0 + 0.5 kg a.i./ha. pendimethalin with terbutryne and prometryne at 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha and metolachlor plus prometryne at 2.0 + 1.0 kg a.i./ha alone produced shoot dry matter at 6 WAS comparable to the hoe-weeded control (Table 56). At 12 WAS, among the weed ocontrol treatments, only metolachlor plus terbutryne at 2.0 + 1.0 followed by 1.0 + 0.5 kg a.i./ha, metolachlor plus prometryne at 2.0 + 1.0 kg a.i./ha alone and 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha resulted in similar shoot dry matter production to the highest obtained with metolachlor plus terbutryne at 2.0 + 1.0 kg a.i./ha alone.

4.2.8 Fruit Yiled

4.2.8.1 Number of fruits

Variety of okra did not differ significantly in the number of fruits produced per square metre in all the trials. However, fruit number per square metre was significantly affected by weed control treatments (Tables 57 to 60). At Kadawa in 1984 and 1985 dry seasons, crop in all the herbicide treated plots produced higher number of

Table 57 Effect of variety and weed control treatments on the yield of okra at Kadawa in 1984 dry season.

Treatments		Fruit No./m²	yield (t/ha)
Variety			
V35		9.64	3.69
TAE-38		11.70	4.28
SE (±)		0.972	0.131
		NS	NS
Weed control+	Rate (kg a.i/ha)		
Metolachlor+terbutryne	1.0+0.5	11.70b[1]	3.60e-h
Metolachlor+terbutryne	2.0+1.0	14.93ab	5.54abc
Metolachlor +prometryne	1.0+0.5	9.70b	3.43e-h
Metolachlor+prometryne	2.0+1.0	16.18ab	6.32b
Diphenamid+terbutryne	1.0+0.5	7.14	2.58gh
Diphenamid+terbutryne	2.0+1.0	7.73b	2.46gh
Diphenamid+prometryne	1.0+0.5	7.51b	2.73gh
Diphenamid+prometryne	2.0+1.0	10.25b	3.70e-h
Pendimethalin+terbutryne	1.0+0.5	7.19b	3.00f-h
Pendimethalin+terbutryne	2.0+1.0	9.53b	3.16f-h
Pendimethalin+prometryne	1.0+0.5	12.84b	4.64c-e
Pendimethalin+prometryne	2.0+1.0	13.67ab	5.12bc
Alachlor+terbutryne	1.0+0.5	11.11b	4.14d-f
Alachlor+terbutryne	2.0+1.0	5.97b	2.43h
Alachlor+prometryne	1.0+0.5	11.48b	3.81d-g
Alachlor+prometryne	2.0+1.0	11.07b	3.68e-h
Weeded check at 3,6&9 WAS[2]	-	22.96a	10.98a
Untreated control	-	1.24c	0.14j
SE (±)		2.910	0.402
		*	*
Interaction			
Variety x weed control		NS	NS

+ All the herbicide treated plots were supplementarily weeded at 6WAS.
1 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT).
2 Weeks after sowing
NS, * = Not significant, significant at 5 % level of probability.

Table 58 Effects of variety and weed control treatments on the yield of okra at Kadawa in 1985 dry season.

Treatments		Fruit yield	
		No./m²	t/ha
Variety			
V35		2.56	2.10
TAE-38		2.32	1.89
SE (±)		0.211 NS	0.263 NS
Weed control	Rate (kg a.i/Ha)		
Metolachlor+terbutryne	2.0+1.0	1.65cd[1]	1.17c
"	2.0+1.0fb[2] 1.0+0.5	1.23cd	0.68c
"	2.0+1.0fb SHW[3]	5.38b	4.14b
"	1.0+0.5fb 1.0+0.5	0.54d	0.31c
Metolachlor+prometryne	2.0+1.0	2.49cd	1.69bc
"	2.0+1.0fb 1.0+0.5	3.14c	2.62bc
"	2.0+1.0fb SHW	8.30a	8.26a
"	1.0+0.5fb 1.0+0.5	1.26cd	0.85c
Pendimethalin+terbutryne	2.0+1.0	0.48d	0.26c
"	2.0+1.0fb 1.0+0.5	0.75d	0.45c
"	2.0+1.0fb SHW	2.92c	1.64bc
"	1.0+0.5fb 1.0+0.5	0.51d	0.25c
Pendimethalin+prometryne	2.0+1.0	1.58cd	1.04c
"	2.0+1.0fb 1.0+0.5	0.96cd	0.49c
"	2.0+1.0fb SHW	2.94c	2.28bc
"	1.0+0.5fb 1.0+0.5	1.21cd	0.76c
Weeded check at 3, 6&9 WAS[4]		8.57a	9.04a
Untreated control		0.0e	0.0d
SE (±)		0.624 *	0.772 *
Interaction			
Variety x weed control		NS	NS

1 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

2 Followed by supplementary hoe-weeding at 6 WAS.

3 Supplementarily hoe-weeded at 6 WAS

4 Weeks after sowing

NS, * = Not significant, significant at 5% level of probability.

Table 59 Effects of variety and weed control treatments on the yield of okra at Samaru in 1984 wet season.

Treatments		Fruit yield No./m²	Fruit yield t/ha
Variety			
V35		8.64	2.83a[1]
TAE-38		7.02	2.10b
SE (±)		0.641	0.240
		NS	*
Weed control	Rate (kg a.i/ha)		
Metolachlor+terbutryne	2.0+1.0	9.83bcd	3.33b-e
"	2.0+1.0fb[2]1.0+0.5	12.37abc	4.43abc
"	2.0+1.0fb SHW[3]	17.88a	5.97a
"	1.0+0.5fb 1.0+0.5	6.05cde	1.61def
Metolachlor+prometryne	2.0+1.0	7.68cde	2.60c-f
"	2.0+1.0fb 1.0+0.5	9.83bcd	3.68a-d
"	2.0+1.0fb SHW	15.63ab	5.07abc
"	1.0+0.5fb 1.0+0.5	14.44ab	4.92abc
Pendimethalin+terbutryne	2.0+1.0	2.25e	0.43f
"	2.0+1.0fb 1.0+0.5	4.94de	1.39def
"	2.0+1.0fb SHW	6.30cde	1.65def
"	1.0+0.5fb 1.0+0.5	2.12e	0.30f
Pendimethalin+terbutryne	2.0+1.0	1.33e	0.19f
"	2.0+1.0fb 1.0+0.5	2.72e	0.70f
"	2.0+1.0fb SHW	3.43de	0.71f
"	1.0+0.5fb 1.0+0.5	3.73de	1.04ef
Weeded check at 3,6&9 WAS[4]	-	17.14a	5.74ab
Untreated control	-	3.28e	0.58f
SE (±)		1.910	0.733
		*	*
Interaction			
Variety x weed control		NS	*

1 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

2 Followed by post emergence herbicide application at 3 WAS.
3 Supplementarily hoeweeded at 6 WAS.
4 Weeks after sowing.
NS, * = Not significant, significant at 5% level of probability.

Table 60 Effects of variety and weed control treatments on the yield of okra at Samaru in 1985 wet season.

Treatments		Fruit yield No./m²	Fruit yield t/ha
Variety			
V35		5.88	3.81
TAE-38		6.95	4.02
SE (±)		0.714	0.501
		NS	NS
Weed control	Rate (kg a.i/ha)		
Metolachlor+terbutryne	2.0+1.0	7.21b-f[1]	5.04de
Metolachlor+terbutryne	2.0+1.0fb 1.0+0.5	6.62c-f	3.17fgh
"	2.0+1.0fb SHW	7.60b-e	4.80def
"	1.0+0.5fb 1.0+0.5	5.82b-f	4.20efg
Metolachlor+prometryne	2.0+1.0	6.12b-f	3.71efg
"	2.0+1.0fb 1.0+0.5	8.44a-e	5.14cde
"	2.0+1.0fb SHW	15.11a	9.78a
"	1.0+0.5fb 1.0+0.5	8.86a-d	5.90bcd
Pendimethalin+terbutryne	2.0+1.0	4.43c-f	2.52ghi
"	2.0+1.0fb 1.0+0.5	1.38ef	0.62j
"	2.0+1.0fb SHW	9.81abc	6.04bcd
"	1.0+0.5fb 1.0+0.5	2.21def	1.06ij
Pendimethalin+prometryne	2.0+1.0	3.51c-f	1.38ij
"	2.0+1.0fb 1.0+0.5	0.36f	0.16ij
"	2.0+1.0fb SHW	12.92ab	7.55b
"	1.0+0.5fb 1.0+0.5	3.63c-f	1.73hij
Weeded check at 3,6&9 WAS[4]	-	11.96ab	6.84bc
Untreated control	-	1.54ef	0.76j
SE (±)		2.122	1.492
		*	*
Interaction			
Variety x weed control		NS	NS

1 Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

2 Followed by post-emergence herbicide application at 3 WAS.

3 Supplementarily hoe-weeded at 6 WAS.

4 Weeks after sowing.
NS, * = Not significant, significant at 5% level of probability.

fruits than the untreated control. In 1984 dry season, crop treated with mixtures of metdachlor with terbutryne and prometryne and pendimethalin plus prometryne, each at 2.0 + 1.0 kg a.i./ha, produced comparable number of fruits to the hoe-weeded control (Table 57). In 1985 dry season, no fruit was produced on the untreated plots and only plot treated with metolachlor plus prometryne at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding produced number of fruits that were comparble to the hoe-weeded control (Table 58). Metolachlor plus terbutryne at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding also resulted in higher number of fruits than the remaining herbicide treatments. Except with pendimethalin plus prometryne, plots given supplementary hoe-weeding had higher fruit numbers than the other treatments of the same mixture in this trial.

At Samaru, plots treated with metolachlor plus prometryne at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding and at 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha produced fruit numbers that were comparable to the hoe0weeded control and significantly higher than the untreated check in both 1984 and 1985 wet seasons (Tables 59 and 60). In addition, metolachlor plus terbutryne at 2.0 + 1.0 followed by 1.0 + 0.5 kg a.i./ha or supplementary hoe-weeding also resulted in fruit numbers that were comparable to the hoe-weeded control

and higher than the untreated control in 1984 wet season (Table 59). In 1985, the number of fruits produced in plots treated with mixtures of pendimethalin with terbutryne and prometryne, each at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding were similarly comparable to that of the hoe-weeded and higher than the untreated control. In the trial, fruit number obtained with pendimethalin plus prometryne at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding was significantly higher than those of other herbicide treatments of the same mixture (Table 60).

4.1.8.2 Weight of fruits

Okra fruit yield was significantly affected by variety at Samaru in 1984 wet season; variety V35 produced higher yield than TAE-38 (Table 59). Fruit yield was however significantly affected by weed control treatments in all the trials (Table 57 to 60). In the two dry season trials conducted at Kadawa, all the weed control treatments resulted in higher fruit yield than the untreated control. In 1984 dry season, none of the herbicide treatments was comparable to the hoe-weeded control in fruit yield. Both metolachlor plus terbutryne and pendimethalin plus prometryne, each at 2.0 + 1.0 kg a.i./ha resulted in similar fruit yield to the best herbicide treatment obtained with the same rate of metolachlor plus prometryne. Apparently, okra fruit yields obtained with higher rates of

metolachlor based mixtures were significantly more compared with the low rate (Table 57). In 1985 dry season, metolachlor plus prometryne at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding resulted in fruit yield comparable to the hoe-weeded control. In this trial, okra fruit yields with metolachlor mixtures followed by supplementary hoe-weeding were significantly higher than those of the corresponding treatments of the same mixture without hoe-weeding (Table 58).

At Samaru in 1984 wet season, mixtures of metolachlor with prometryne and terbutryne, each at 2.0 + 1.0 followed by 1.0 + 0.5 kg a.i./ha or supplementary hoe-weeding, metolachlor plus prometryne at 1.0 + 0.5 kg followed by 1.0 + 0.5 kg a.i./ha resulted in fruit yields that were comparable to the hoe-weeded control and higher than the untreated check. Except metolachlor plus terbutryne at 2.0 + 1.0 kg a.i./ha alone, the remaining herbicide treatments did not differ significantly in fruit yields from the untreated check (Table 59). However, in 1985 wet season, the highest okra fruit yield which was significantly higher than those of all the other treatments was obtained with metolachlor plus prometryne at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding (Table 60). Plots treated with metolachlor plus prometryne at both rates and followed by 1.0 + 0.5 kg a.i./ha and mixtures of pendimethalin with terbutryne and prometryne, each at

2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding produced okra fruit yields that were comparablet to the hoe-weeded control. In this trial, supplementary hoe-weeding improved fruit yield significantly within each mixture compared with the application of metolachlor plus prometryne and pendimethalin mixtures alone.

There was significant interaction between variety and weed control treatments on okra fruit yield at Samaru in 1984 wet season (Table 61). In variety V35, among the herbicide treatments, metolachlor plus prometryne at 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha and hoe-weeded control resulted in okra fruit yield that was comparable to the best obtained with metolachlor plus terbutryne at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding while with variety TAE-38 only metolachlor plus pprometryne at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding was comparable.

4.2.9 Relationship between various parameters and fruit yield of okra in the weed control studies at Kadawa and Samaru.

Okra fruit yield was positively correlated with crop vigour score, shoot dry matter, plant height (except at Kadawa in 1985 dry season) and fruit number per square metre and negatively correlated with the weed cover score in all the experiments (Table 62).

Table 61 Interaction of variety and weed control treatments on okra fruit yield at Samaru in 1984 wet season.

Treatments Weed control	Rate (kg a.i/ha)	Okra fruit yield (t/ha) V35	 TAE-38
Metolachlor+terbutryne	2.0+1.0	3.27c-h[1]	3.39c-h
"	2.0+1.0fb[2] 1.0+0.5	4.45b-e	4.41b-e
"	2.0+1.0fb SHW	8.95a	2.99d-h
"	1.0+0.5fb 1.0+0.5	0.76fgh	2.45d-h
Metolachlor +prometryne	2.0+1.0	4.18b-g	1.02e-h
"	2.0+1.0fb 1.0+0.5	4.57b-e	2.80d-h
"	2.0+1.0fb SHW	3.51c-h	6.63abc
"	1.0+0.5fb 1.0+0.5	6.01a-d	3.83b-h
Pendimethalin+terbutryne	2.0+1.0	0.37h	0.49h
"	2.0+1.0fb 1.0+0.5	2.37e-h	0.41h
"	2.0+1.0fb SHW	1.50e-h	1.80e-h
"	1.0+0.5fb 1.0+0.5	0.16i	0.44h
Pendimethalin+prometryne	2.0+1.0	0.16i	0.23h
"	2.0+1.0fb 1.0+0.5	0.97e-h	0.42h
"	2.0+1.0fb SHW	0.76fgh	0.67fgh
"	1.0+0.5fb 1.0+0.5	1.10e-h	0.97e-h
Weeded check at 3, 6&9 WAS[4]	-	7.20ab	4.28b-f
Untreated control	-	0.58gh	0.59gh
SE (±)		1.043	

1 Means followed by the same letter(s) within rows and column are not significantly different at 5% level of probability (DMRT)

2 Followed by post-emergence herbicide application at 3 WAS.

3 Supplementarily hoe-weeded at 6 WAS.

4 Weeks after sowing.

Table 62 Relationship between various parameters and fruit yield of okra in the chemical weed control studies at Kadawa and Samaru.

Parameters	r value			
	Kadawa		Samaru	
	1984	1985	1984	1985
Crop vigour score at 6 WAS[1]	0.714**	0.632**	0.736**	0.605**
Shoot dry matter at 6 WAS	0.644**	0.610**	-	0.270**
Plant height at harvest	0.686**	0.225NS	0.620**	0.256*
Fruit number/m^2	0.937**	0.943**	0.976**	0.955**
Weed cover score at 6 WAS	-0.338**	-0.413**	-0.238*	-0.156NS
Weed dry matter at harvest	-0.117NS	-0.085NS	-0.192NS	-0.118NS

1 Weeks after sowing

* and ** = Significant at 5% and 1% level of probability, respectively.

NS = nt Not significant

4.3 Effect of Variety and Weed Control Treatments on the Nutrient Contents of Okra Fruits

Varieties of okra differed significantly in viscosity, ash and crude protein contents of fruit at Kadawa in 1984 and 1985 dry seasons (Tables 63, 64 and 65). Although variety TAE-38 contained higher per cent ash and crude protein than V35, the latter was found to be more viscous than the former.

Weed control treatments had significant effect on the viscosity of okra fruit at Kadawa in both seasons. In 1984, mixtures of metolachlor with terbutryne and prometryne, pendimethalin plus terbutryne and alachlor plus prometryne, all at 1.0 + 0.5 kg a.i./ha, diphenamid plus terbutryne at 2.0 + 0.5 kg a.i./ha as well as the hoe-weeded control resulted in significantly lower viscosity than the highest obtained with diphenamid plus prometryne and pendimethalin plus terbutryne, each at 2.0 + 1.0 kg a.i./ha (Table 63). In 1985, at the same location, no okra fruit was produced in the untreated plots to carry out analysis and therefore figures were not available for this treatment. Metolachlor plus terbutryne at 2.0 + 1.0 kg a.i./ha followed by 1.0 + 0.5 kg a.i./ha, pendimethalin plus terbutryne at 2.0 + 1.0, 2.0 + 1.0 kg a.i./ha followed by 1.0 + 0.5 kg a.i./ha and 1.0 + 0.5 fb 1.0 + 0.5 kg a.i./ha and pendimethalin plus prometryne at 1.0 + 0.5 fb 1.0 + 0.5 kg a.i./ha as well as the hoe-weeded control

Table 63 Effects of variety and weed control treatments on viscosity, ascorbic acid and ash contents of okra fruits at Kadawa in 1984 dry season.

Treatments		Viscosity (centipoise)	Ascorbic acid (mg/100g)	Ash (%)
Variety		[1]		
V35	-	3375a	37.0	4.68b
TAE-38		2905b	32.1	6.07a
SE (±)		86.2	2.86	0.43
		*	NS	
Weed control[+]	Rate (kg a.i/ha)			
Metolachlor+terbutryne	1.0+0.5	2780bc	50.8	6.03
"	2.0+1.0	3350abc	36.5	4.45
Metolachlor+prometryne	1.0+0.5	2475c	41.8	3.65
"	2.0+1.0	3130abc	40.8	6.55
Dipehanmid+terbutryne	1.0+0.5	3365abc	40.5	3.13
"	2.0+1.0	2865bc	35.0	6.58
Diphenamid+prometryne	1.0+0.5	3325abc	54.5	4.08
"	2.0+1.0	3830a	33.3	7.25
Pendimethalin+terbutryne	1.0+0.5	2550c	28.3	5.35
"	2.0+1.0	3830a	58.3	3.70
Pendimethalin+prometryne	1.0+0.5	3095abc	24.3	7.18
"	2.0+1.0	3220abc	23.8	4.30
Alachlor+terbutryne	1.0+0.5	3165abc	18.5	4.10
"	2.0+1.0	3190abc	28.8	5.63
Alachlor+prometryne	1.0+0.5	2780bc	26.8	6.98
"	2.0+1.0	3175abc	32.5	4.53
Weeded check at 3,6&9 WAS[2]	-	2735bc	24.5	6.30
Untreated control	-	3561ab	24.0	6.58
SE(±)		258.6	8.58	1.30
		*	NS	NS
Interaction				
Variety x weed control				

+ All the herbicide treated plots were supplementarily weeded at 6 WAS.

1 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT).

2 Weeks after sowing.

NS, * = Not significant, significant at 5% level of probability.

Table 64 Effects of variety and weed control treatments on viscosity, ascorbic acid and ash contents of okra fruits at Kadawa in 1985 dry season.

Treatments		Viscosity (centipoise)	Ascorbic acid (mg/100g)	Ash (%)
Variety				
V35		3073	34.6	5.36
TAE-38		3158	35.8	5.22
SE (±)		91.3	2.93	0.45
		NS	NS	NS
Weed control	Rate (kg a.i/ha)			
Metolachlor+terbutryne	2.0+1.0	3480a-d[1]	38.5	4.9
"	2.0+1.0fb[2] 1.0+0.5	2715b-e	39.0	4.2
"	2.0+1.0fb SHW[3]	3740ab	46.3	4.3
"	1.0+0.5fb 1.0+0.5	3785a	54.3	5.1
Metolachlor+prometryne	2.0+1.0	3480a-d	47.3	3.6
"	2.0+1.0fb 1.0+0.5	3260a-e	24.0	5.3
"	2.0+1.0fb SHW	3535abc	24.8	3.8
"	1.0+0.5fb 1.0+0.5	3210a-e	34.0	4.6
Pendimethalin+terbutryne	2.0+1.0	2615cde	45.3	6.3
"	2.0+1.0fb 1.0+0.5	2600de	48.0	4.8
"	2.0+1.0fb SHW	2995a-e	41.8	5.5
"	1.0+0.5fb 1.0+0.5	2655cde	30.8	6.1
Pendimethalin+prometryne	2.0+1.0	3080a-e	29.5	6.9
"	2.0+1.0fb 1.0+0.5	3175a-e	36.3	6.1
"	2.0+1.0fb SHW	3260a-e	22.3	4.7
"	1.0+0.5fb 1.0+0.5	2550e	24.5	6.8
Weeded check at 3,6&9 WAS[4]	-	2825b-e	22.0	6.8
SE (±)		266.1	8.53	1.30
		*	NS	NS
Interactions				
Variety x weed control		NS	NS	NS

1 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT).

2 Followed by post-emergence herbicide application at 3 WAS.

3 Supplementarily hoe-weeded at 6 WAS.

4 Weeks after sowing

NS, , * = Not significant, significant at 5% level of probability.

Table 65 Effects of variety and weed control treatments on soluble carbohydrate and crude protein contents of okra fruits at Kadawa in 1985 dry season.

Treatments		Soluble carbohydrate (%)	Crude protein (%)
Variety			
V35		27.5	16.5b[1]
TAE-38		27.9	17.7a
SE (±)		1.95 NS	0.22 **
Weed control	Rate (kg a.i/ha)		
Metolachlor+terbutryne	2.0+1.0	29.8	18.5ab
"	2.0+1.0fb[2] 1.0+0.5	21.2	18.2abc
"	2.0+1.0fb SHW[3]	31.7	17.5a-d
"	1.0+0.5fb 1.0+0.5	43.1	16.9a-d
Metolachlor+prometryne	2.0+1.0	25.3	18.5ab
"	2.0+1.0fb 1.0+ 0.5	26.9	16.4b-e
"	2.0+1.0fb SHW	18.9	17.4a-d
"	1.0+0.5fb 1.0+0.5	15.4	18.3abc
Pendimethalin+terbutryne	2.0+1.0	17.2	16.3b-e
"	2.0+1.0fb 1.0+0.5	24.9	15.8de
"	2.0+1.0fb SHW	25.4	16.9a-d
"	1.0+0.5fb 1.0+0.5	29.9	19.2a
Pendimethalin+prometryne	2.0+1.0	30.5	16.2cde
"	2.0+1.0fb 1.0+0.5	35.3	14.3e
"	2.0+1.0fb SHW	28.4	16.9a-d
"	1.0+0.5fb 1.0+ 0.5	32.7	17.3a-d
Weeded check at 3,6&9WAS[4]	-	35.1	15.9de
SE (±)		5.69	0.04
		NS	**
Interactions			
Variety x weed control		NS	**

1 Means followed by the same letter(s) within the same column or treatment are not significantly different at 5% level of probability (DMRT).

2 Followed by post-emergence application of herbicide at 3 WAS.

3 Supplementarily hoe-weeded at 6 WAS

4 Weeks after sowing.

NS, ** = Not significant, significant at 1% level of probability, respectively.

resulted in significantly lower viscosity than the highest obtained with metlachlor plus terbutryne at 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha (Table 64).

Weed control treatments also had significant effect on per cent crude protein content of okra fruit at Kadawa in 1985 dry season (Table 65). Metolachlor plus prometryne at 2.0 + 1.0 fb 1.0 + 0.5 kg a.i./ha, mixtures of pendimethalin with terbutryne and prometryne, each at 2.0 + 1.0 kg a.i./ha and followed by 1.0 + 0.5 kg a.i./ha and the hoe-weeded control had significantly lower percent crude protein than all other herbicide treatments.

The interaction between variety and weed control treatments was significant on crude protein content of fruit at Kadawa in 1985 dry season (Table 66). In variety V35 fruits produced on plots treated with mixtures of metolachlor with terbutryne and prometryne at 2.0 + 1.0 fb 1.0 + 0.5 kg a.i./ha and 2.0 + 1.0 kg a.i./ha, respectively and pendimethalin plus terbutryne at 2.0 + 1.0 fb SHW and 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha. had per cent crude protein comparable to the highest obtained with metolachlor plus terbutryne at 2.0 + 1.0 kg a.i./ha. In TAE-38, fruits produced on plots treated with mixture of metolachlor with terbutryne at 2.0 + 1.0 kg a.i./ha followed by 1.0 + 0.5 kg a.i./ha, metolachlor plus prometryne at 2.0 + 1.0, 2.0 + 1.0 kg a.i./ha followed

Table 66 Interaction between variety and weed control treatments on crude protein content of okra fruits at Kadawa in 1985 dry season.

Weed control	Rate (kg a.i/ha)	Crude protein (%)	
		V35	TAE-38
Metolachlor+terbutryne	2.0+1.0	19.9abc[1]	17.1c-f
"	2.0+1.0fb[2] 1.0+0.5	17.9a-e	18.5a-e
"	2.0+1.0fb SHW[3]	17.1c-f	17.8b-f
"	1.0+0.5fb 1.0+0.5	16.3d-g	17.5c-f
Metolachlor+prometryne	2.0+1.0	18.4a-e	18.7a-d
"	2.0+1.0fb 1.0+0.5	11.8hi	20.9ab
"	2.0+1.0fb SHW	16.03d-g	18.7a-d
"‡	1.0+0.5fb 1.0+0.5	15.6e-g	21.1a
Pendimethalin+terbutryne	2.0+1.0	13.5g-i	19.2abc
"	2.0+1.0fb 1.0+0.5	15.4efg	16.1d-g
"	2.0+1.0fb SHW	19.1a-d	14.6fgh
"	1.0+0.5fb 1.0+0.5	18.3a-e	20.2abc
Pendimethalin+prometryne	2.0+1.0	14.7fgh	17.7b-f
"	2.0+1.0fb 1.0+0.5	17.3c-f	11.4i
"	2.0+1.0fb SHW	16.1d-g	17.8b-f
"	1.0+0.5fb 1.0+0.5	17.5c-f	17.1c-f
Weeded check at 3,6&9 WAS[4]	-	15.5efg	16.4dg
SE (±)		0.899	

1 Means followed by the same letter(s) within rows and columns are not significantly different at 5% level of probability (DMRT).

2 Followed by post-emergence herbicide application at 3WAS.

3 Supplementary hoe-weeding at 6 WAS.

4 Weeks after sowing.

by half the rate three weeks later and supplementary hoe-weeding and pendimethalin plus terbutryne at 1.0 + 0.5 fb 1.0 + 0.5 kg a.i./ha had per cent crude protein comparable to that obtained from metolachlor plus prometryne at 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha.

Table 67 Effects of variety and weed control treatments on viscosity and ascorbic acid contents of okra fruits at Samaru in 1985 wet season.

Treatments		Viscosity (centipoise)	Ascorbic acid (mg/100g)
Variety			
V35		3045	24.0
TAE-38		2954	26.9
SE (±)		99.6	0.01
		NS	NS
Weed control	Rate (kg a.i/ha)		
Metolachlor+terbutryne	2.0+1.0	3140	24.2
"	2.0+1.0fb[1] 1.0+0.5	3130	24.2
"	2.0+1.0fb SHW[2]	3500	26.4
"	1.0+0.5fb 1.0+0.5	3350	26.4
Metolachlor+prometryne	2.0+1.0	3000	28.6
"	2.0+1.0fb 1.0+0.5	2900	26.4
"	2.0+1.0fb SHW	3170	26.4
"	1.0+0.5fb 1.0+0.5	3400	22.0
Pendimethalin+terbutryne	2.0+1.0	2830	24.2
"	2.0+1.0fb 1.0+0.5	2710	33.0
"	2.0+1.0fb SHW	3250	22.0
"	1.0+0.5fb 1.0+0.5	2400	24.2
Pendimethalin+prometryne	2.0+.10	2900	28.6
"	2.0+1.0fb 1.0+0.5	3040	26.4
"	2.0+1.0fb SHW	3200	22.0
"	1.0+0.5fb 1.0+0.5	2900	26.4
Weeded check at 3,6&9 WAS[3]	-	2900	24.2
Untreated control	-	2200	22.0
SE (±)		298.9	0.03
Interaction			
Variety x weed control		NS	NS

1 Followed by post-emergence herbicide application at 6 WAS.

2 Supplementarily hoe-weeded at 3 WAS

3 Weeks after sowing.

NS = not significant.

Table 68 Effects of variety and weed control treatments on soluble carbohydrate and crude protein contents of okra fruits at Samaru in 1985 wet season.

Treatments		Soluble carbohydrate (%)	Crude protein (%)
Variety			
V35		21.01	19.8
TAE-38		23.1	20.7
SE (±)		1.25	0.49
Seed Control	Rate (kg a.i/ha)		
Metolachlor+terbutryne	2.0+1.0	22.2	17.6
"	2.0+1.0fb[1] 1.0+0.5	25.3	20.1
"	2.0+1.0fb SHW[2]	23.3	17.3
"	1.0+0.5fb 1.0+0.5	20.0	19.7
Metolachlor+prometryne	2.0+1.0	27.7	20.3
"	2.0+1.0fb 1.0+0.5	23.1	20.2
"	2.0+1.0fb SHW	30.9	19.2
"	1.0+0.5fb 1.0+0.5	24.2	20.2
Pendimethalin+terbutryne	2.0+1.0	24.0	22.3
"	2.0+1.0fb 1.0+0.5	11.7	21.9
"	2.0+1.0fb SHW	20.6	21.4
"	1.0+0.5fb 1.0+0.5	26.7	22.3
Pendimethalin+prometryne	2.0+1.0	17.8	18.5
"	2.0+1.0fb 1.0+0.5	14.1	22.3
"	2.0+1.0fb SHW	23.4	21.2
"	1.0+0.5fb 1.0+0.5	20.9	20.0
Weeded check at 3,5&9 WAS[3]	-	23.1	21.0
Untreated control	-	17.9	19.0
SE (±)		3.74	1.47
		NS	NS
Interaction			
Variety x weed control		NS	NS

1 Followed by post-emergence herbicide application at 3 WAS.

2 Supplementarily hoe-weeded at 6 WAS.

3 Weeks after sowing.

NS = Not significant.

Chapter 5

DISCUSSION

In the weed interference experiments, the highest mean value of okra fruit yield of 10.3 t/ha was obtained when the crop was kept weed-free throughout the growth period as there was no weed competition. This yield compared favourably with the mean yield of 13.8 t/ha reported by Fatokun and Chheda (1983) at Ibadan in the forest zone and higher than 5.4 t/ha obtained by Majanbu et al. (1985) at Samaru in the northern Guinea savanna of Nigeria. The mean fruit yield (12.1 t/ha) obtained in the wet season at Samaru was higher than that obtained (9.9 t/ha) in the dry seasons at Kadawa despite the fact that plants were taller and had higher shoot dry matter production during the two dry seasons than at Samaru in the wet season. Okra is a warm season crop whose growth and development is markedly influenced by temperature and known to grow well at temperatures of between 25 and 40°C (Grubben, 1977). The warm temperatures (25 to 30°C) in late February andin March were probably adequate for okra growth and any early retardation in growth due to low temperatures (20°C) in early February could have been overcome (Fig. 2). The low yield was most likely due to unfavourably high temperatures during flowering and fruit development in April and May which aided abortion of fruits. This result is

in conformity with the findings of Bisaria and Shamshery (1979) in India who obtained highest okra fruit yield in the rainy season compared with the winter and summer seasons. In Nigeria, Fatokun and Chheda (1983) also reported differences in okra fruit yields due to seasonal variations during the early (April) and late (August) planted crop durations.

Similarly, the highest mean okra fruit yield (7.6 t/ha) obtained on plots treated with herbicides and later supplemented with hoe-weeding was comparable to the mean yield (8.2 t/ha) obtained from the hoe-weeded controls in the various weed control trials thus confirming the possibility of using herbicide as a good alternative to hand-weeding for effective weed control and consequently high okra fruit yields (Sinha et al., 1982; Ogungbile and Lagoke, 1986). In the Nigerian savanna, various workers have emphasized the need to supplement pre-emergence herbicide treatments with hoe-weeding for season-long weed control and increased yield in vegetables such as pepper and onion (Adigun et al., 1987; Lagoke et al., 1988). However, the application of directed post-emergence herbicide treatments aimed at removing the need for supplementary hoe-weeding resulted in low okra fruit yields. This was because despite the fact that directed post-emergence herbicide treatments effectively controlled weeds, they were phytotoxic to okra plant as reflected in depressed height, crop vigour, shoot dry matter production, and fruit yield.

5.1 Effect of Variety on Okra and Weeds

In this investigation, variety TAE-38 was taller and produced more vegetation that V35 although yield from V35 was more in 1984. Similarly, even-though TAE-38 had longer days to flowering than V35, it had significantly lower yield than V35 in 1984. The lack of significant difference in most of the growth characters and yield between the two varieties could be explained by the fact that they are both improved varieties with similar growth and development patterns. Adelana (1981) working on okra varieties V35 and Jokoso found no difference in the growth pattern and the number of flowers and fruits produced. In contrast, Majanbu et al. (1985) reported significant differences in growth characters and yield of the two varieties of okra tested under rain-fed conditions at Samaru. The varieties used (NHAE 47-4 and white velvet) were however different in growth pattern both between themselves and the ones used in this study. Rao (1972) reported that the number of days to flowering in okra is more of varietal characteristic as observed in this investigation.

Variety of okra had no obvious effect on weed cover score and dry matter production of various categories of weeds because of their similar growth patterns such as plant height, leaf number and arrangement which did not allow for effective suppression of weeds.

The results of biochemical analysis indicated varietal differences in viscosity, ash and crude protein contents of fruits at Kadawa in 1984 and 1985 dry seasons, respectively. Variety V35 contained lower per cent ash and crude protein but showed more viscosity than TAE-38 . This could be due to varietal differences in the nutrient contents between the varieties rather than environmental effect since the two varieties were grown under the same soil and climatic conditions in both seasons. Similar results have been reported by Okoh (1984) that variations in the nutrient composition of vegetables including okra were due partly to varietal differences and differences in time of cultivation and soil composition. Uzo and Ojiako (1980) also reported that okra variety 'Awgu Early' had significantly higher viscosity and was the best cultivar among seven cultivars tested. The lack of significant difference in the nutrient contents of the varieties at Samaru in 1985 wet season could be attributed to differences in time of cultivation and soil composition between Samaru and Kadawa.

5.2 Effect of Nitrogen on Okra and Weeds

In the weed interference experiments, the response of growth characters such as crop vigour, leaf and shoot dry matter production at various times to nitrogen application at Kadawa in 1985 was not manifested in fruit yield, while in other years there was lack of response of

these characters and yield of okra to nitrogen. Although the soils of the experimental sites used in this investigation contained low values of total nitrogen (0.01 to 0.04%) which should have warranted response to nitrogen fertilization, the influence of applied nitrogen on growth and yield was minimal. This may be attributed to the low pH of the soils resulting in reduced plant growth due to acid soil infertility (Sanchez, 1976). Ahmad and Tullock-Reid (1965) had earlier observed that the acidic nature of the soil (pH 4.5) contributed to the lack of response of okra to applied nitrogen and lower uptake of other nutrients. Similar results were obtained by other workers in India who reported lack of response of growth characters such as plant height, dry weight per plant and days to flowering (Chauhan and Gupta, 1973), and fruit yield (Randhawa and Pannum, 1969) to nitrogen application. Nevertheless, both Shrestha (1983) and Majanbu et al. (1985) observed lack of response of fruit yield to nitrogen fertilization in one year and a significant response in the following year.

The lack of significant effect of nitrogen on plant height partly explains the lack of response of fruit yield to nitrogen since this parameter is an important yield determinant in okra (Roy and Chhonkar, 1976; Fatokun and Chheda, 1983).

The response of only broad-leaved weed dry matter production to applied nitrogen during 1985 wet season was

because broad-leaved weeds emerge much later than grasses in the wet season. Application of nitrogen was done at 3 and 6 WAS which prevented the grass weeds from benefitting from the nutrient supply as much as the late-emerging broad-leaved weeds.

5.3 Effect of Period of Weed Interfernce on Okra

Weed infestation throughout the crop life-cycle depressed the growth and yield of okra in all the experiments. This resulted in reduced fruit yield by 88 and 90% during the 1984 and 1985 dry seasons, respectively and 98% in 1985 wet season compared with the maximum yield obtained when the crop was kept weed-free throughout its growth period. Unchecked weed growth in okra has been reported to cause yield losses of 62% (William and Warren, 1975), 81% (Singh et al. 1981), 73% (Lagoke et al., 1983) and 79% (Adejonwo et al., 1987) compared with the maximum obtained in their various studies.

Initial weed infestation for the first 3 WAS did not have any adverse effect on okra plant as reflected in crop vigour, plant height, leaf number, shoot dry matter, days to flowering, fruit yield. This was because at the early stage of growth, weeds were too young and not well established to compete seriously with the crop. In addition, at the initial stages of growth, both crop and weeds have

adequate amount of light, nutrients and water relative to their requirements, hence the crop was not seriously affected. Similar results have been reported in the Nigerian savanna by several workers that weed infestation for the first 3 WAS did not cause any significant depression in crop growth and yield of pepper (Adigun et al., 1982; Lagoke et al., 1988), cotton (Dadari, 1983; Okafor, 1987) and maize (Bakut, 1985). However, weed infestation until 6 WAS depressed crop growth characters and yield compared with crop weed-infested for 3 WAS only.

The highest increase in okra fruit yield at 1.68 t/ha per week in 1984 and 1985 dry season trials occurred when the crop was kept weed-free between 3 and 6 and 6 and 9 WAS, respectively. In 1985 wet season, the highest gain in fruit yield of 0.70 t/ha per week was obtained when the crop was kept weed-free beyond 12 WAS until harvest.

The differences in weed-free periods needed to obtain the highest increase in yield between the seasons could be attributed to the higher weed challenge during the 1985 dry season compared with the dry season of 1984. In 1985 wet season, however, weed challenge was much greater than during the dry seasons due to more favourable climatic conditions which necessitated weed control beyond 12 WAS to obtain highest increased in yield.

Conversely, the highest reduction in okra fruit yields of 1.95, 2.08 and 2.30 t/ha per week in 1984, 1985 dry and 1985 wet seasons respectively were obtained when the crop was weed-infested for the period between 3 and 6 WAS. This seemed to be the most critical period of weed competition with the crop since it was during this period of okra growth that the crop was most susceptible to weed interference. Nieto et al. (1968) had earlier observed that the period of crop growth when it is most susceptible to weed interference should be regarded as the most critical period of weed competition with the crop. In this study, weed infestation for 6 WAS resulted in the greatest reduction in okra fruit yield and subsequent weed removal did not obviate the effect on yield compared with the unweeded control. This suggests that the ci critical period of weed competition with okra was between 3 and 6 WAS. This result is similar to the findings of William and Warren (1975) that the critical period of weed competition with okra occurred between 3 and 7 WAS.

As shown in Figures 3 and 5, weeding of the crop needs to begin as early as 3 weeks after sowing to avoid yield loss due to weed interference. Highest yields were obtained on plots kept weed-free throughout the growth period in all the trials although yields from these plots were similar to that obtained from plots kept weed-free for 12 WAS at Kadawa in 1985. For maximum yield, the crop requires a weed-free

period of 12 WAS or more. The apparent increase in weed-free period requirement in the wet season compared with the dry seasons was probably due to higher weed challenge as a result of more favourable temperature. Furthermore, in the dry season, broadleaved weeds emerged earlier than the grasses and sedges. In contrast, in the wet season, grasses are the first category of weeds to emerge and the broadleaved weeds and sedges appear later in the season. Generally, broadleaved weeds compete more seriously with crops than grass weeds because of the obvious morphological differences between these two types of weeds such as the leaf shape and arrangement. This explains why a crop grown in the wet season requires a longer weed-free period than the crop grown in the dry season. Shadbolt and Holm (1956) had reported that the precise time and duration of periods of maximum competition depend on factors such as relative growth of the crop and weeds, density of planting, variety grown and time of moisture and nutrient stress. Also important is the relative positions of crop and weed (plant distribution or the planting pattern).

5.4 Effect of Weed Control Treatments on Weeds and the Crop

At Kadawa in 1984, before supplementary hoe-weeding at 6 WAS, none of the pre-emergence herbicide treatments gave effective weed reduction comparable to the hoe-weeded

control as reflected in the weed cover score at 6 WAS. Weed dry matter production at 6 WAS with the herbicide treatments did not also differ significantly from that of the untreated check in the trial. It is therefore essential that pre-emergence herbicides be supplemented by other weed control measures in situations where weed infestation is high for season-long weed reduction. Such measures which include supplementary hoe-weeding, post-emergence application of some herbicide applied pre-emergence at half the rate or split-application of the same herbicide mixture at pre- and post-emergence were evaluated in subsequent trials. Earlier reports by Bakut (1985), Adigun et al. (1987) and Lagoke et al.(1987) have emphasized the need to supplement pre-emergence herbicide treatments with post-emergence application for season-long weed control in the Nigerian savanna. In this investigation however, only at Samaru in 1984 wet season was split application of metolachlor plus terbutryne at 2.0 + 1.0 followed by 1.0 + 0.5 kg a.i./ha and metolachlor plus prometryne at 1.0 + 0.5 followed by 1.0 + 0.5 kg a.i./ha able to provide adequate weed control with consequent high okra pod yields comparable to the hoe-weeded control. The failure of directed post-emergence herbicide treatment combinations to produce high okra pod yields despite effective weed control at the early stage of

crop growth could be attributed to the phytotoxic effect of the treatments on okra plants as reflected in lower crop vigour, number of leaves per plant and shoot dry matter production compared with supplementary hoe-weeding.

It is apparent that the treatment involving metolachlor plus prometryne followed by supplementary hoe-weeding was most consistent in combining effective weed control with good crop growth and high okra pod yield. The yields obtained from this treatment were comparable to the hoe-weeded control in all the trials except at Kadawa in 1984 dry season where it resulted in the highest okra yield among the herbicide treatments. The low yield of about 58% of that of the hoe-weeded control which was obtained this time might be attributed to the intensity of weed competition with the crop before supplementary hoe-weeding was carried out at 6 weeks after sowing. Expectedly, this would have adverse effect on fruit yield considering the fact that okra plant starts flowering at about 7 weeks after sowing. The low okra fruit yield notwithstanding, mixtures of metolachlor with terbutryne and prometryne and pendimethalin plus prometryne, each at 2.0 + 1.0 kg a.i./ha still produced comparable number of fruits to the hoe-weeded control. In India, Rajagopal and Ashok-Metha (1979) observed that pre-emergence application of prometryne at 0.5 to 1.0 kg/ha supplemented with one hand-weeding resulted in

the highest okra fruit yield comparable to the hand-weeded control. Similarly, it has been reported in the West Indies that pre-emergence application of prometryne at 2.0 kg/ha maintained good weed control 42 days after treatment and resulted in the highest fruit yield although slight initial injury to plants was caused by the herbicide (Brathwaite, 1981). Lagoke et al. (1983) reported that metolachlor plus terbutryne and alachlor plus prometryne, each at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding resulted in okra pod yields similar to two and three hoe-weedings. Adejonwo et al. (1987) also reported that mixtures of metolachlor with terbutryne at 1.0 + 1.0 kg a.i./ha and metolachlor plus prometryne at 1.5 + 1.5 kg a.i./ha, each followed by supplementary hoe-weeding resulted in effective weed control and high yields of both maize and okra.

Weed control treatments did not significantly influence the nutrient contents of fruits except viscosity and ash content in 1984 and crude protein in 1985 dry season at Kadawa. The mucilaginous product of a blended okra fruit is a viscoelastic substance which exhibits both elastic and viscous properties. Viscosity, therefore, is the property of a fluid in resisting change in the shape or arrangement of its elements during flow and the degree to which this property exists in a particular fluid (Uzo and Ojiako, 1980). Although many factors influence

viscosity such as atmospheric pressure, temperature, stage of maturity of the plant organ and plant growing environment in the field (Uzo and Ojiako, 1980), yet viscosity gives a valid comparison of okra sliminess under the same conditions of test. Herbicides that interfere with carbohydrate synthesis in plants such as the triazines may probably affect viscosity since mucilage is made up of polysaccharides.

According to Akobundu (1987), protein synthesis is quite sensitive to herbicides and most herbicides such as the chloroacetamides that interfere with phosphorylation and nucleic acid metablism also inhibit it. The action of dinitroanilines on protein synthesis, however, may be indirect resulting from interference with the action, development and transport of hormones (Fryer and Makepeace, 1977). Similar results have been reported by Bulus (1986) that soluble carbohydrates and crude protein contents of potato tuber were significantly affected by weed control treatments. On the contrary, Brathwaite (1981) did not observe any changes in okra fruit quality, total carbohydrate, protein, fat or moisture contents as a result of herbicide treatments. Dobrzanski (1978) also reported that herbicides have no effect on total sugars in onions and vitamin C in Brussels sprouts.

5.5 Interactions

Plant characters such as crop vigour score, shoot dry matter production and days to 50% and 100% flowering were significantly different between the varieties depending on the extent of weed interference. These differences however were not reflected in okra fruit yield. It was apparent that variety TAE-38 was less susceptible to weed interference especially at the early stage of growth than V35. This may be attributed to the fact that V35 matures earlier than TAE-38 as shown by the number of days to flowering and therefore it is more susceptible to weed interference.

The influence of the interaction between nitrogen and period of weed interference on plant height and fruit number in 1985 and 1984 respectively at Kadawa showed that crop only responded to weed removal when nitrogen was applied. Apparently, only plants treated with nitrogen at 75 and 150 kg/ha had comparable height when plots were kept weed-free for 12 WAS and longer and also after initial infestation for 3 WAS. Similarly, in 1984 at Kadawa, increasing the nitrogen level from 0 and 75 kg/ha to 150 kg/ha caused crop weed-infested for 3 WAS also to have lower fruit number than those obtained on plots kept weed-free throughout the growth period.

Similarly, significant nitrogen and period of weed interference interaction on okra fruit yield observed in 1984 revealed that fruit yield increased as nitrogen level was increased from 0 to 75 kg/ha and later to 150 kg/ha in crop weed-free throughout the growth period. However, weed infestation for 3 and 6 WAS resulted in decreased okra fruit yield as nitrogen level was increased from 75 to 150 kg/ha. Weed infestation beyond 6 WAS resulted in drastic reduction in fruit yield irrespective of nitrogen level. It is therefore obvious from the foregoing that nitrogen application beyond 75 kg/ha enhanced weed growth to the detriment of the crop. In addition, severe weed infestation could reduce the beneficial effect of nitrogen application to the crop. This result is in agreement with the finding of Buchanan and Mclaughlin (1975) that application of higher rate of nitrogen benefitted weeds more than crops.

The interaction between variety and weed control treatments was significant on crop vigour score at 6 WAS and fruit yield at Samaru in 1985 and 1984, respectively, as well as crude protein content of okra fruits at Kadawa in 1985. The results indicated that variety V35 was more vigorous in growth at the early stage and therefore less susceptible to herbicide treatments than TAE-38. This explains why variety V35 out-yielded TAE-38 under the same herbicide treatments at Samaru in 1984. This is in

agreement with the views of Wax et al. (1974) that there are many instances of intraspecific selectivity to herbicides within species which may result in poor weed control or injury to the crop. Differential response to herbicides have also been reported among cultivars in maize (Eastin, 1971), soyabean (Burnside, 1972) and cowpea (Akobundu, 1985). Herbicide treatments particularly split applications of mixtures of pendimethalin with terbutryne and prometryne considerably increased crude protein content of okra fruits in variety V35 than TAE-30. Earlier reports on plant response to the triazine herbicides attributed the increases in plant protein in treated plants to atrazine-induced yield increase (Ries et al., 1970).

5.6 Correlation

In this investigation, okra fruit yield was highly positively correlated with crop vigour score, shoot dry matter, plant height and fruit number in each of the seasons. This revealed that active vegetative growth encourages dry matter accumulation and the transportation of photosynthate from source to sink during flowering and pod formation. Okra plant bears fruit from the axillary bud and the number of fruits produced per plant depends on the number of nodes and internodes. This is clearly reflected in the results of this study where the number of fruits per unit area was

highest in the 1985 dry season when the okra plant also attained the tallest height in these series of trials. But for the unfavourably high temperatures during fruit development in April and May which caused individual fruits to be smaller than those of the wet season crop, yield per hectare would also be higher for the dry season crops. Similar results have been reported by several workers that okra fruit yield was significant and positively correlated with plant height and fruit number (Sing et al., 1976; Roy and Chhonkar, 1976; Fatokun and Chheda, 1983).

The highly significant and negative correlations obtained between fruit yield and days to 50% flowering, weed cover score and weed weight may be attributed to the fact that the earlier the crop starts flowering in relation to the growing season, the more fruits are produced. Also, rapid weed biomass production results in greater crop-weed competition for light, nutrients and water and consequently less fruit yield is produced. Adigun (1984), Bakut (1985) and Bulus (1986) have all reported that yields of their respective crops were negatively correlated with weed cover score and weed weight.

Chapter 6

SUMMARY AND CONCLUSION

Field experiments were conducted at the Irrigation Research Station, Kadawa (in the Sudan savanna) and College of Agriculture Farm at Samaru (in the northern Guinea savanna) during the 1984 and 1985 dry and wet seasons, respectively. The aim was to study the effect of nitrogen on the response of two varieties of okra (Abelmoschus esculentus L. Moench) to various periods of weed interference and to identify suitable herbicide treatment combinations for season-long weed control in the crop.

The weed interference experiment was laid out in a split plot design and replicated three times. The main treatments consisted of two varieties of okra (V35 and TAE-38) and three nitrogen levels (0, 75 and 150 kg N/ha) in a factorial combination while the sub-treatments were made up of ten periods of weed interference. One set of treatments consisted of plots kept weed-free initially for 3, 6, 9 and 12 weeks after sowing (WAS) while the other set consisted of plots weed-infested for the corresponding periods stated above. Two treatments in which the plots were kept weed-free and weed-infested throughout the crop growth period were also included as controls.

In the weed control study, factorial combinations of these two okra varieties and sixteen herbicide treatments together with hoe-weeded and untreated controls were laid out

in a randomized complete block design and replicated three times. The herbicide treatments at Kadawa in 1984 consisted of mixtures of terbutryne and prometryne with metolachlor, alachlor, diphenamid and pendimethalin, each at 1.0 + 0.5 kg a.i./ha and 2.0 + 1.0 kg a.i./ha, all applied pre-emergence and followed by supplementary hoe-weeding at 6 WAS. In subsequent trials, only promising treatments from the 1984 experiment including mixtures of metolachlor and pendimethalin with terbutryne and -prometryne were applied pre-emergence at two rates and followed by directed post-emergence application of half of the high rate applied pre-emergence or supplemented with hoe-weeding.

The results obtained in this investigation indicated that okra varieties V35 and TAE-38 were similar in growth, yield and in their responses to nitrogen application. However, variety V35 contained higher crude protein and showed more viscosity than TAE-38. Variety of okra had no obvious effect on weed cover score and weed dry matter production because of their similar growth pattern as exemplified by the plant height, leaf number and arrangement and shoot dry matter production.

Keeping the crop weed-free until 3 WAS did not prevent depression in growth and yield of okra due to the adverse effect of subsequent weed infestation. Conversely, weed infestation until 3 WAS had no adverse effect on okra plants. Infestation until 6 WAS however depressed the height,

vigour, shoot dry matter production, fruit number and yield of okra. The crop seemed to be most critically affected by weed interference between 3 and 6 WAS. The practical significance of this finding is that weed removal in the crop should start from 3 WAS and not earlier. For maximum fruit yield, the crop requires a weed-free period of 12 WAS and longer.

In the weed control experiment, it was apparent that pre-emergence herbicide treatments could not effectively control weeds beyond 6 WAS. Among the herbicide treatments, metolachlor plus prometryne at 2.0 + 1.0 kg a.i./ha followed by supplementary hoe-weeding was most consistent in combining good weed control with high okra fruit yield at levels comparable to three hoe-weedings. Directed post-emergence herbicide treatments controlled weeds better than pre-emergence treatments alone but they were phytotoxic to okra plant as reflected in depressed crop growth characters and low okra fruit yields.

Significant effect of weed control treatments on fruit viscosity and crude protein content was observed, thus indicating possible effect of herbicides on metabolic processes such as carbohydrate and protein synthesis in okra.

In all the experiments, uncontrolled weed growth throughout the crop life-cycle significantly depressed crop vigour, height, leaf number, shoot dry matter production.

It also reduced okra fruit yield by 92% and 94% compared with the best treatments in the weed interference and chemical weed² control trials, respectively.

It is suggested that the next phase of research work on chemical weed control in okra should look into ways of ameliorating the phytotoxic effect of directed post-emergence herbicide treatments on the crop in order to remove the need for supplementary hoe-weeding in its production. In order to eliminate supplementary weeding, there is need to grow low-growing okra varieties using close spacing which would quickly shade the soil surface and suppress subsequent weed growth. Other areas of research aimed at reducing phytotoxicity of post-emergence directed sprays should include (a) the use of safeners to enhance herbicide selectivity. Safeners increase the effectiveness of weed control because they make it possible to use larger doses of herbicides without crop injury thereby controlling weeds that would have been only marginally controlled without the safeners, and (b) screening large populations of okra varieties for differential response of the herbicides.

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Appendix 1 Common and chemical names, LD_{50} and solubility of herbicides mentioned in the text

Common Name	Chemical Name	Oral LD_{50} for rats (mg/kg)	Solubility in water at 20°C (ppm)
Metolachlor	2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxyl-1-methyl ethyl)acetamide	2,535	530
Alachlor	2-chloro-2,6-diethyl-N-(methoxymethyl) acetanilide	1,800	148
Terbutryne	2-(tert-butylamino-4-(ethylamino)-6-methythio-5-triazine	2,500	25
Prometryne	4,6-bio-isoprophyl amino-2-methlthio-1, 3,5-triazine	3,750	48
Diphenamid	N,N-dimethyl-2,2-diphenylacetamide	1,373	0.026
Pendimethalin	N-(1-ethylpropyl)-3,4-dimethyl-2, 6-dinitrobenzenamine	5,000	0.3

Appendix 2: Fitted values of fruit yields (t/ha) for V35 and TAE-38 okra varieties at harvest as affected by period of weed interference at Kadawa, 1984 dry season.

Period (weeks)	Initially weed-free		Initially weed-infested	
	V35	TAE-38	V35	TAE-38
0	1.08	0.27	10.98	9.97
3	1.53	1.52	8.08	7.37
6	5.74	3.78	3.26	3.13
9	8.11	5.54	0.28	0.65
12	7.86	6.24	0.10	0.73
15	6.91	6.24	0.91	1.59

Appendix 3 Values of regression coefficient for fitted curves on V35 and TAE-38 okra fruit yields at Kadawa, 1984 dry season.

	Initially weed-free		Initially weed-infested	
	V35	TAE-38	V35	TAE-38
a	-1.081	0.27	10.98	9.97
b_2	0.416	0.19	-0.46	-0.41
b_3	-0.046	-0.02	0.05	0.05

Appendix 4: Fitted values of fruit yields (t/ha) for V35 and TAE-38 okra fruit yields at Kadawa, 1985 dry season.

Period (weeks)	Initially weed-free		Initially weed-infested	
	V35	TAE-38	V35	TAE-38
0	2.52	3.12	13.16	16.03
3	3.03	3.20	10.16	11.92
6	4.55	4.31	5.02	4.96
9	6.78	4.881	1.52	0.38
12	8.99	10.06	0.80	-0.33
15	10.06	11.79	1.35	0.56

Appendix 5: Values of regression coefficient for fitted curves on V35 and TAE-38 okra fruit yields at Kadawa, 1985 dry season.

	Initially weed-free		Initially weed-infested	
	V35	TAE-38	V35	TAE-38
a	2.52	3.12	13.16	16.03
b_2	0.05	0.03	-0.47	-0.64
b_3	0.02	0.01	0.05	0.07

Appendix 6: Fitted values of fruit yields (t/ha) for V35 and TAE-38 okra varieties at harvest as affected by period of weed interference at Samaru, 1985 wet season.

Period (weeks)	Initially weed-free		Initially weed-infested	
	V35	TAE-38	V35	TAE-38
0	5.41	9.13	11.12	9.77
3	5.76	8.22	8.04	7.85
6	6.76	7.51	3.06	4.31
9	8.21	8.61	0.23	1.47
12	9.63	11.16	0.47	0.23
15	10.31	12.85	1.56	0.15

Appendix 7 Values of regression coefficient for fitted curves on V35 and TAE-38 okra fruit yields at Samaru, 1985 wet season.

	Initially weed-free		Initially weed-infested	
	V35	TAE-38	V35	TAE-38
a	5.41	9.13	11.12	9.77
b_2	0.04	-0.18	-0.49	-0.29
b_3	0.01	0.03	0.05	0.03

Appendix 8: Mean squares from analysis of variance for crop vigour score as affected by variety, nitrogen and period of weed interference at Kadawa, 1984 dry season.

Source of variation	Df	Crop Vigour Score at: 6WAS	9WAS	12 WAS
Replication	2	11.84	15.02	0.13
Variety	1	0.31	3.20	1.01
Nitrogen	2	3.30	8.08	6.09
Variety x Nitrogen	2	5.01	5.20	0.69
Error (a)	10	3.57	3.89	3.67
Treatment	9	121.14**	139.95**	134.62**
Var. x Treatment	9	1.55	1.24	0.75
NxTreatment	18	1.23	1.28	1.48
Var. x N x Treatment	18	1.58	2.27	1.57
Error (b)	108	1.72	1.85	2.28
Total	179			

** F value significant at 1% level of probability

WAS = weeks after sowing

Appendix 9: Means squares from analysis of variance for crop vigour score as affected by variety, nitrogen and period of weed interference at Kadawa, 1985 dry season.

Source of variation	Df	Crop Vigour Score at: 6 WAS	9 WAS	12 WAS
Replication	2	4.64	3.26	0.69
Nitrogen	2	12.85	16.01	24.64**
Variety	1	4.29	0.90	5.87
Nitrogen x Variety	2	6.94	0.43	1.90
Error (a)	10	4.77	3.98	1.66
Treatment	9	30.55**	103.69**	119.38**
N x Treatment	18	1.13	1.38	1.07
V x Treatment	9	0.92	1.10	2.60**
N x V x Treatment	18	1.16	1.56	0.88
Error (b)	108	0.88	1.02	1.01
Total	179			

** F value significant at 1% level of probability

WAS = weeks after sowing

Appendix 10: Means squares from analysis of variance for crop vigour score as affected by variety, nitrogen and period of weed interference at Samaru, 1985 wet season.

Source of Variance	Df	Crop Vigour Score at: 6 WAS	9 WAS	12 WAS
Replication	2	4.08	30.67	17.74
Nitrogen	2	0.85	6.94	3.92
Variety	1	6.88	10.27	8.02
Nitroven x Variety	2	6.57	8.87	3.66
Error (a)	10	3.90	10.76	5.85
Treatment	9	31.14**	35.34**	54.89**
N x Treatment	18	2.31	3.43	1.89
Variety x Treatment	9	1.18	3.29	1.58
N x V x Treatment	18	2.03	4.50	1.99
Error (b)	108	1.76	5.03	2.15
Total	179			

** F value significant at 1% level of probability

WAS = weeks after sowing.

Appendix 11 Means squares from analysis of variance for number of leaves/m^2 as affected by variety, nitrogen and period of weed interference at Kadawa, 1985 dry season.

Source of variation	Df	Number of leaves/m^2 at: 6 WAS	9 WAS	12 WAS
Replication	2	2.61	13.34	46.2
Nitrogen	2	5.34	285.24*	453.3
Variety	1	5.34	149.42	310.4
Nitrogen x Variety	2	0.44	59.07	342.2
Error (a)	10	4.20	39.07	114.1
Treatment	9	16.35**±	255.20**	1157.9**
Nitrogen x Treatment	18	2.69	13.02	100.8
V x Treatment	9	3.73	14.10	160.7
N x V x Treatment	18	2.22	7.90	80.5
Error (b)	108	2.61	8.54	104.5
Total	179			

* F value significant at 5% level of probability

** F value significant at 1% level of probability

WAS = weeks after sowing

Appendix 12 Mean squares from aanalysis of variance for number of leaves/m² as affected by variety, nitrogen, and period of weed interference at Samaru, 1985 wet season.

Source of variation	Df	Number of leaves/m² at: 6 WAS	9 WAS	12 WAS
Replication	2	1.32	84.51	3.17
Nitrogen	2	2.96	33.06	5.38
Variety	1	1.66	0.31	0.55
Nitrogen x Variety	2	0.80	20.57	13.71*
Error (a)	10	11.17	23.21	2.65
Treatment	9	24.08**	42.12**	6.00**
N x Treatment	18	5.35	10.58	2.06
V x Treatment	9	6.71	5.28	2.32
N x V x Treatment	18	7.32	12.38	2.06
Error (b)	108	5.57	10.83	2.26
Total	176			

* F value significant at 5% level of probability

** F value significant at 1% level of probability

WAS = weeks after sowing.

Appendix 13: Means squares from analysis of variance for plant height as affected by variety, nitrogen and period of weed interference at Kadawa, 1984 dry season.

Source of variation	Df	Plant height at harvest
Replication	2	2452.3
Variety	1	1045.7
Nitrogen	2	87.8
Variety x Nitrogen	2	89.7
Error (a)	10	431.1
Treatment	9	5425.4**
Variety x Treatment	9	95.5
N x Treatment	18	190.3
V x N x Treatment	18	124.9
Error (b)	108	137.1
Total	179	

** F value significant at 1% level of probability

WAS = weeks after sowing.

Appendix 14: Mean squares from analysis of variance for plant height as affected by variety, nitrogen and period of weed interference at Kadawa, 1985 wet dry season.

Source of variation	Df	Plant height at 6 WAS	9WAS	harvest
Replication	2	206.72	358.9	2774.7
Nitrogen	2	69.65	319.9	1647.2
Variety	1	36.45	81.3	8.4
Nitrogen x Variety	2	183.52	350.3	623.9
Error (a)	10	26.04	287.4	1169.9
Treatment	9	32.22	3084.1	13342.1**
N x Treatment	18	23.60	126.5	1706.8**
V x Treatment	9	33.28	144.1	839.6
N x V x Treatment	18	18.75	105.2	943.9
Error (b)	108	22.06	148.5	702.9
Total	179			

** F value significant at 1% level of probability

WAS = weeks after sowing

Appendix 15 Mean squares from analysis of variance for plant height as affected by variety, nitrogen, period of weed interference at Samaru, 1985 wet season.

Source of variation	Df	Plant height at. 6 WAS	9 WAS	harvest
Replication	2	761.89	2709.5	1047.3
Nitrogen	2	335.45**	73.6	1919.1
Variety	1	374.52**	4387.5**	4157.2
Nitrogen x Variety	2	536.90	446.5	3029.5
Error (a)	10	25.95	383.8	915.3
Treatment	9	77.82	297.9*	1113.0*
N x Treatment	18	54.11	115.9	286.8
V x Treatment	9	35.73	246.0	525.8
N x V x Treatment	18	30.79	109.9	371.1
Error (b)	108	45.67	141.9	525.4
Total	179			

** F value significant at 1% level of probability

* F value significant at 5% level of probability

WAS = weeks after sowing

Appendix 16 Means squares from analysis of variance for shoot dry matter production as affected by variety, nitrogen and period of weed interference at Kadawa, 1984 dry season.

Source of variation	Df	Shoot dry matter production at: 9 WAS	harvest
Replication	2	731	5867
Variety	1	3975	15578*
Nitrogen	2	2015	9023
Variety x Nitrogen	2	1780	3072
Error (a)	10	2034	2432
Treatments	9	18999**	25576**
V x Treatment	9	766	2259
N x Treatment	18	1156	1824
V x N x Treatment	18	2392	1330
Error (b)	108	1627	2088
Total	179		

* F value significant at 5% level of probability

** F value significant at 1% level of probability

WAS = weeks after sowing

Appendix 17 Means squares from analysis of variance for shoot dry matter production as affected by variety, nitrogen and period of weed interference at Kadawa, 1985 dry season.

Source of variation	Df	Shoot dry matter production at: 9 WAS	harvest
Replication	2	2009.2	18722
Nitrogen	2	11043.5*	7893
Variety	1	4774.1	6509
Nitrogen x Variety	2	142.8	5945
Error (a)	10	2510.1	7265
Treatment	9	29455.3**	34673**
Nitrogen x Treatment	18	1256.5	3252
V x Treatment	9	1632.9	5892**
N x V x Treatment	18	790.3	1975
Error (b)	108	850.1	2222
Total	179		

1* F value significant at 5% level of probability

** F value significant at 1% level of probability

WAS = weeks after sowing

Appendix 18 Mean squares from analysis of variance for shoot dry matter production as affected by variety, nitrogen and period of weed interference at Samaru, 1965 wet season.

Source of variation	Df	Shoot dry matter production at: 6 WAS	9 WAS	harvest
Replication	2	888.27	607.0	3645.7
Nitrogen	2	176.68	851.9	1101.3
Variety	1	7.47	2661.2	31.4
Nitrogen x Variety	2	123.37	1541.7	3755.5
Error (a)	10	69.97	971.9	1711.8
Treatment	9	381.00**	1402.9**	4485.5**
N x Treatment	18	68.80	230.8	529.5
V x Treatment	9	21.21	179.4	1184.0
N x V x Treatment	18	55.64	197.8	1018.3
Error (b)	108	56.19	214.9	904.5
Total	179			

** F value significant at 1% level of probability

WAS = weeks after sowing

Appendix 19: Mean squares from analysis of variance for days to first flowering as affected by variety, nitrogen and period of weed interference at Kadawa and Samaru.

Source of variation	Df	Days to flowering		
		Kadawa 1984	Kadawa 1985	Samaru 1985
Replication	2	8.34	14.57	36.87
Nitrogen	2	7.41	1.11	18.20
Variety	1	102.76**	145.80	9.34
Nitrogen x Variety	2	4.24	15.35	11.36
Error (a)	10	10.59	20.08	12.81
Treatment	9	37.86**	160.78**	16.85**
Nitrogen x Treatment	18	7.10	13.73	2.73
V x Treatment	9	6.15	18.80	8.54
N x V x Treatment	16	7.89	16.52	4.85
Error (a)	108	6.18	15.28	4.90
Total	179			

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

WAS = weeks after sowing

Appendix 20: Mean squares from analysis of variance for days to 50% flowering as affected by variety, nitrogen and period of weed interference at Kadawa and Samaru.

Source of variation	Df	Days to 50% flowering		
		Kadawa		Samaru
		1984	1985	1985
Replication	2	95.91	53.35	64.07
Nitrogen	2	16.94	2.51	27.02
Variety	1	224.45*	145.28	8.45
Nitrogen x Variety	2	11.02	27.03	3.72
Error (a)	10	44.17	36.24	9.49
Treatment	9	85.72**	440.17**	10.04*
N x Treatment	18	12.58*	34.73	2.41
V x Treatment	9	15.56*	5.45	7.28
N x V x Treatment	18	9.29	17.51	3.64
Error (b)	108	6.99	22.86	4.45
Total	179			

* F value significant at 5% level of probability

** F value significant at 1% level of probability

WAS = weeks after sowing.

Appendix 21: Mean squares from analysis of variance for days to 100% flowering as affected by variety, nitrogen and period of weed interference at Kadawa and Samaru.

Source of variation	Df	Days to 100% flowering		
		Kadawa		Samaru
		1984	1985	1985
Replication	2	409.65	37.24	76.44
Nitrogen	2	66.12	60.42	15.02
Variety	1	158.67	403.42	5.69
Nitrogen x Variety	2	23.51	167.33	3.76
Error (a)	10	70.78	98.06	7.36
Treatment	9	93.00**	585.89**	19.94**
Nitrogen x Treatment	18	10.39	55.95*	4.41
V x Treatment	9	15.83	59.78*	5.18
N x V x Treatment	18	14.55	63.92	3.31
Error (b)	108	10.58	28.27	4.72
Total 179	179			

* F value significant at 5% level of probability

** F value significant at 1% level of probability

WAS = weeks after sowing

Appendix 22: Means squares from analysis of variance for days for fruit number as affected by variety, nitrogen and period of weed interference at Kadawa and Samaru.

Source of variation	Df	Fruit number		
		Kadawa		Samaru
		1984	1985	1985
Replication	2	4584	12832	27504
Nitrogen	2	3818	11854	899
Variety	1	342	22854	13523
Nitrogen x Variety	2	1372	6746	1014
Error (a)	10	3499	7914	25177
Treatment	9	35986**	115650*	41104**
Nitrogen x Treatment	18	2520*	4352	3625
V x Treatment	9	934	5113	6504
N x V x Treatment	18	1997	4059	5728
Error (b)	108	1459	3703	5413
Total	179			

* F value significant at 5% level of probability

** F value significant at 1% level of probability

WAS = Weeks after sowing

Appendix 23 Mean squares from analysis of variance for fruit yield as affected by variety, nitrogen and period of weed interference at Kadawa and Samaru.

Source of variation	Df	Fruit yield		
		Kadawa		Samaru
		1984	1985	1985
Replication	2	1.83×10^6	2949369	48.31×10^6
Nitrogen	2	2.16×10^6	7398554	0.56
Variety	1	1.81×10^6	80909	1.72×10^6
Nitrogen x Variety	2	0.68×10^6	2061180	3.81×10^6
Error (a)	10	1.99×10^6	3139120	13.38×10^6
Treatment	9	2.07×10^6**	34752302**	35.84×10^6
N x Treatment	18	1.79×10^6	715904	2.72×10^6
V x Treatment	9	0.83×10^6	465904	2.72×10^6
N x V xTreatment	18	0.92×10^6	432512	1.67×10^6
Error (b)	108	0.92×10^6	943762	2.58×10^6
Total	179			

** F value significant at 1% level of probability

WAS = weeks after sowing

Appendix 24: Means squares from analysis of variance for weed cover score as affected by variety, nitrogen and period of weed interference, Kadawa 1984 and 1985 dry seasons.

Source of variation	Df	Weed cover score at 1984 6 WAS	1984 9 WAS	1985 6 WAS	1985 9 WAS
Replication	2	1.08	0.75	0.18	0.86
Variety	1	8.59**	0.005	0.004	1.61
Nitrogen	2	1.71	0.11	1.25	5.14*
Nitrogen x Variety	2	0.82	0.64	1.24	0.87
Error (a)	10	0.75	1.57	1.13	0.96
Treatment	9	219.18**	254.14**	232.24**	286.50**
V x T	9	0.95	0.55	0.72	1.98
N x T	18	1.06	1.43	1.57	0.86
V x N x T	18	0.21	0.77	1.43	0.84
Error (b)	108	0.75	0.89	1.59	1.00
Total	179				

** F value significant at 1% level of probability

WAS = weeks after sowing

Appendix 25 Mean squares from analysis of variance for weed cover score as affected by variety, nitrogen and period of weed interference at Samaru, 1985 wet season.

Source of variation	Df	Weed cover score at: 6 WAS	9 WAS	12 WAS
Replication	2	17.04	1.52	2.49
Nitrogen	2	0.29	2.45	4.27
Variety	1	0.26	2.11	0.94
Nitrogen x Variety	2	4.21	0.58	3.28
Error (a)	10	3,68	6.84	1.63
Treatment	9	69.68**	101.13**	171.55**
N x T	18	1.09	4.91	2.69
V x Treatment	9	1.73	5.83	4.52
N x V x Treatment	18	1.63	8.99	2.29
Error (b)	108	1.67	6.27	3.12
Total	179			

** F value significant at 1% level of probability

WAS = weeks after sowing

Appendix 26 Mean squares from analysis of variance for cummulative weed dry matter as affected by variety, nitrogen and period of weed interference at Kadawa, 1985 dry season.

Source of variation	Df	Weed dry matter		
		Grasses	Broad-leaves	Sedges
Replication	2	654	1626	6517
Nitrogen	2	1757	5126	3735
Variety	1	926	1407	4057
Nitrogen x Variety	2	4880	1571	835
Error (a)	10	3072	1697	2607
Treatment	9	22765**	31893**	29756**
Nitrogen x Treatment	18	1170	2148	840
V x Treatment	9	2814	1074	1855
N x V x Treatment	18	2839	2910	1313
Error (b)	108	1984	2379	1336
Total	179			

** F value significant at 1% level of probability

WAS = weeks after sowing

Appendix 27: Mean squares from analysis of variance for cummulative weed dry matter as affected by variety, nitrogen and period of weed interference at Samaru, 1985 wet season.

Source of variation	Df	Weed dry matter		
		Grasses	Broad-leaves	Total
Replication	2	15931	31471	92260
Nitrogen	2	14348	18855*	64877**
Variety	1	13196	7730	672
Nitrogen x Variety	2	5314	7291	23576
Error (a)	10	3974	2597	11679
Treatment	9	24253**	45167**	132538**
N x Treatment	18	955	3431	5646
V x Treatment	9	5848**	7986	24247**
N x V x Treatment	18	1700	3620	7961
Error (b)	108	1982	4294	9986
Total	179			

** F value significant at 1% level of probability

* F value significant at 5% level of probability

Appendix 28: Mean squares from analysis of variance for weed cover score and weed dry matter as affected by variety and weed control treatments at Kadawa, dry season.

Source of variation	Df	Weed cover score at 6 WAS	Weed dry matter at harvest
Replication	2	47.07	10535
Treatments	17	15.93**	8845*
Variety	1	0.006	2635
Treatment x Variety	17	2.99	3908
Residual	70	2.97	4578
Total	107		

Appendix 29: Mean squares from analysis of variance for weed cover score and weed dry matter as affected by variety and weed control treatments at Kadawa, 1985 dry season.

Source of variation	Df	Weed cover score at		Weed dry matter at harvest
		6 WAS	9 WAS	
Replication	2	1.24	1.43	99656
Treatment	17	23.98**	52.75**	17824**
Variety	1	0.04	1.02	12416
Treatment x Variety	17	0.66	1.06	8213
Residual	70	1.13	1.47	13618
Total	107			

** F value significant at 1% level of probability
WAS = weeks after sowing.

Appendix 30: Mean squares from analysis of variance for weed cover score and weed dry matter as affected by variety and weed control treatments at Samaru, 1984 wet season.

Source of variation	Df	Weed cover score at 6 WAS	Weed cover score at 9 WAS	Weed dry matter at 6 WAS
Replication	2	2.13	2.90	166.85
Treatment	17	29.21**	33.26**	4812.59**
Variety	1	0.39	1.47	764.86
T x Variety	17	1.61	1.16	1371.95
Residual	70	1.63	1.58	777.80
Total	107			

Appendix 31 Mean squares from analysis of variance for weed cover score and weed dry matter as affected by variety and weed control treatments at Samaru, 1985 wet season.

Source of variation	Df	Weed cover score at 6 WAS	Weed cover score at 9 WAS	Weed dry matter at harvest
Replication	2	1.09	14.65	2818
Treatment	17	9.97**	32.34**	3882*
Variety	1	0.00	13.76*	1124
T x Variety	17	1.39	3.90	2110
Residual	70	0.89	3.00	2182
Total	107			

** F value significant at 1% level of probability

* F value significant at 5% level of probability

WAS = weeks after sowing

Appendix 32: Mean squares from analysis of variance for stand count as affected by variety and weed control treatments at Kadawa, 1984 and 1985 dry seasons.

Source of variation	Df	Stand count 1984	Stand count 1985
Replication	2	4.85	40.08
Treatment	17	6.34**	7.55
Variety	1	502.68**	0.75
T x Variety	17	24.26	5.08
Residual	70	14.71	5.82
Total	107		

Appendix 33: Mean squares from analysis of variance for stand count as affected by variety and weed control treatments at Samaru, 1984 and 1985 wet seasons.

Source of variation	Df	Stand count 1984	Stand count 1985
Replication	2	29.01	38.03
Treatment	17	78.70**	14.28
Variety	1	0.59	44.08*
T x Variety	17	6.12	6.79
Residual	70	10.47	10.51
Total	107		

** F value significant at 1% level of probability

* F value significant at 5% level of probability

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Appendix 34: Mean squares from analysis of variance for crop vigour score as affected by variety and weed control treatments at Kadawa, 1984, and 1985 dry seasons.

Source of variation	Df	Crop vigour score at			
		1984		1985	
		6 WAS	12 WAS	6 WAS	12 WAS
Replication	2	1.30	19.29	10.58	5.38
Treatment	17	12.60**	13.10**	8.90**	25.69**
Variety	1	0.02	8.90	8.44**	0.64
T x Variety	17	2.38	3.36	0.55	0.57
Residual	70	1.95	4.10	0.87	0.98
Total	107				

Appendix 35: Mean squares from analysis of variance for crop vigour score as affected by variety and weed control treatments at Samaru, 1984 and 1985 wet seasons.

Source of variation	Df	Crop vigour score at			
		1984		1985	
		6 WAS	12 WAS	9 WAS	9 WAS
Replication	2	0.86	8,78	6.40	16.39
Treatment	17	16.24**	23.01	3.72**	18.52**
Variety	1	8.33*	1.56	2.23	1.33
T x Variety	17	2.38	2.53	2.07*	1.98
Residual	70	1.57	2.02	1.07	1.55
Total	107				

** F value significant at 1% level of probability

* F value significant at 5% level of probability

WAS = weeks after sowing.

Appendix 36: Mean squares from analysis of variance for leaf number as affected by variety and weed control treatments at Kadawa, 1985 dry season.

Source of variation	Df	Number of leaves at 6 WAS	Number of leaves at 9 WAS
Replication	2	0.26	27.01
Treatment	17	1.54	26.58**
Variety	1	0.33	18.75
T x Variety	17	0.59	8.28
Residual	70	1.02	5.53
Total	107		

Appendix 37: Mean squares from analysis of variance for leaf number as affected by variety and weed control treatments at Samaru, 1984 and 1985 wet seasons.

Source of variation	Df	Number of leaves at 1984 9 WAS	1984 12 WAS	1985 9 WAS	1985 12 WAS
Replication	2	25.78	21.92	5.89	25.29
Treatment	17	26.32**	50.17**	3.19	6.84*
Variety	1	1.81	0.44	1.12	0.003
T x Variety	17	7.17	21.65	2.15	2.54
Residual	70	4.60	14.47	2.02	3.29
Total	107				

** F value significant at 1% level of probability

* F value significant at 5% level of probability

WAS = weeks after sowing.

Appendix 38: Mean squares from analysis of variance for plant height as affected by variety and weed control treatments at Kadawa, 1984 and 1985 dry seasons.

		Plant height		
		1984	1985	
Source of variation	Df	harvest	6 WAS	9 WAS
Replication	2	2134.9	66.79	13.03
Treatment	17	1411.9**	45.14**	499.41**
Variety	1	814.6	46.68	78.37
T x Variety	17	568.2	11.44	122.17
Residual	70	476.1	18.10	82.45
Total	107			

Appendix 39: Means squares from analysis of variance for plant height as affected by variety and weed control treatments at Samaru, 1984 wet season.

		Plant height at	
Source of variation	Df	9 WAS	12 WAS
Replication	2	2832.3	10052
Treatment	17	1501.83**	3099.52**
Variety	1	838.45*	502.59
T x Variety	17	442.45*	1208.84
Residual	70	154.92	1149.1
Total	107		

** F value significant at 1% level of probability

* F value significant at 5% level of probability

WAS = weeks after sowing.

Appendix 40: Mean squares from analysis of variance for plant height as affected by variety and weed control treatments at Samaru, 1985 wet season.

Source of variation	Df	Plant height at 6 WAS	9WAS	12 WAS
Replication	2	15.11	343.6	1580.9
Treatment	17	64.28	150.4	778.4*
Variety	1	264.35**	276.5	1756.7*
T x Variety	17	51.68	92.0	398.4
Residual	70	39.85	126.6	440.7
Total	107			

Appendix 41: Mean squares from analysis of variance for shoot dry matter production as affected by variety and weed control treatments at Kadawa, 1984 and 1985 dry seasons.

Source of variation	Df	Shoot dry matter 1984		1985	
		9 WAS	12 WAS	6 WAS	9 WAS
Replication	2	6408	7279	4.29	1158.1
Treatment	17	5866**	7598	96.93**	1714.2**
Variety	1	7798	16268	21.33	135.6
T x Variety	17	881	3488	22.92	316.0
Residual	70	2153	3011	24.49	296.5
Total	107				

* F value significant at 5% level of probability

** F value significant at 1% level of probability

WAS = weeks after sowing

Appendix 42: Mean squares from analysis of variance for shoot dry matter production as affected by variety and weed control treatments at Samaru, 1985 wet season.

Source of variation	Df	Shoot dry matter		
		6 WAS	9 WAS	12 WAS
Replication	2	0.29	515.4	8590
Treatment	17	1.21*	192.5	2291
Variety	1	0.97	0.4	4
T x Variety	17	0.87	99.1	632
Residual	70	0.66	181.3	1396
Total	107			

Appendix 43: Mean squares from analysis of variance for number of okra fruits as affected by variety and weed control treatments at Kadawa, 1984 and 1985 dry season.

Source of variation	Df	Number of okra fruits	
		1984	1985
Replication	2	5350	754.7
Treatments	17	5984**	1760.8
Variety	1	5186	69.3
T x Variety	17	1005	130.1
Residual	70	2319	104.7
Total	107		

* F value significant at 5% level of probability

** F value significant at 1% level of probability

WAS = weeks after sowing

Appendix 44: Mean squares from analysis sof variance for number of okra fruits as affected by variety and weed control treatments as Samaru, 1984 and 1985 wet seasons.

		Number of okra fruits	
Source of variation	Df	1984	1985
Replication	2	10307.8	5631
Treatment	17	8419.02**	4816**
Variety	1	3223.15	1386
T x Variety	17	1627.91	1290
Residual	70	999.13	1227
Total	107		

Appendix 45: Mean squares from analysis of variance for okra fruit yield as affected by variety and weed control treatments at Kadawa, 1984 and 1985 dry seasons.

		Okra fruit yield	
Source of vari ation	Df	1984	1985
Replication	2	2169397	447181
Treatment	17	3423526**	1194835**
Variety	1	1082107	33490
T x Variety	17	416786	151797
Residual	70	976197	101869
Total	107		

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

Appendix 46: Mean squares from analysis of variance for okra fruit yield as affected by variety and weed control treatments at Samaru, 1984 and 1985 wet season.

		Okra fruit yield	
Source of variation	Df	1984	1985
Replication	2	$1.45x10^{7}$	2996406
Treatment	17	$1.13x10^{7}$**	5063882**
Variety	1	$6.48x10^{6}$*	129226
T x Variety	17	$2.80x10^{6}$*	1987091
Residual	70	$1.48x10^{6}$	1517073
Total	107		

Appendix: 47: Mean squares from analysis of variance for viscosity of fruit as affected by variety and weed control treatment at Kadawa, 1984 and 1985 dry seasons.

		Fruit viscosity	
Source of variation	Df	1984	1985
Replication	1	2157**	588.24
Variety	1	3978971**	566206*
Treatment	17	577139*	$3.9x10^{6}$**
V x Treatment	17	306857	323194
Residual	35	275263	283158
Total	71		

** F value significant at 1% level of probability

* F value significant at 5% level of probability

Appendix 48: Mean squares from analysis of variance for ascorbic acid content of fruits as affected by variety and weed control treatments at Kadawa, 1984 and 1985 dry seasons.

		Ascorbic acid	
Source of variation	Df	1984	1985
Replication	1	10272.2	10977.9
Variety	1	430.2	516.48
Treatment	17	514.0	612.00
V x Treatment	17	231.7	222.59
Residual	35	294.9	291.22
Total	71		

Appendix 49: Mean squares from analysis of variance for soluble carbohydrate and crude protein and ash contents of fruits as affected by variety and weed control treatments at Kadawa, 1985 dry season.

Source of variation	Df	Soluble carbohydrate	Crude protein	Ash
Replication	1	1.65×10^{9}	4.71	138.65
Variety	1	1.00×10^{8}	14.04**	7.66
Treatment	17	2.48×10^{8}	9.26*	32.07
V xTreatment	17	1.62×10^{8}	6.27**	1.53
Residual	35	1.30×10^{8}	1.62	6.80
Total	71			

** F value significant at 1% level of probability

* F value significant at 5% level of probability

Appendix 50: Mean squares from analysis of variance for viscosity and ascorbic acid of fruit as affected by variety and weed control treatment at Samaru, 1985 wet season.

Source of variation	Df	Viscosity	Ascorbic acid
Replication	1	1.92×10^{6}	0.02 3
Variety	1	149422	$6.88 \times 10_{3}$
Treatment	17	407059	3.24×10^{3}
V x Treatment	17	335069	3.69×10^{3}
Residual	35	357234	3.76×10^{3}
Total	71		

Appendix 51: Mean squares from analysis of variance for soluble carbohydrate and crude protein contents of fruits as affected by variety b and weed control treatments at Samaru, 1985 wet season.

Source of variation	Df	Soluble carbohydrate	Crude protein
Replication	1	1.07×10^{9}	7.13
Variety	1	8.47×10^{7}	13.24
Treatment	17	8.71×10^{7}	9.42
V x Treatment	17	3.82×10^{7}	5.75
Residual	35	5.53×10^{7}	8.59
Total	71		

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"	Lecturer I	1981	1987
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