RESPONSE OF BLACKGRAM (*Phaseolus mungo* L. Hepper) TO LAND CONFIGURATION AND WEED MANAGEMENT PRACTICES UNDER SOUTH GUJARAT CONDITIONS

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ABSTRACT

RESPONSE OF BLACKGRAM (*Phaseolus mungo* (L.) Hepper) TO LAND CONFIGURATION AND WEED MANAGEMENT PRACTICES UNDER SOUTH GUJARAT CONDITIONS

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ABSTRACT

A field experiment was conducted during *kharif* season of 2001 at the College Farm, Gujarat Agricultural University, Navsari Campus, Navsari to study the, "Response of blackgram (*Phaseolus mungo* (L.) Hepper) to land configuration and weed management practices under South Gujarat conditions". The soil of experimental field was clayey in texture, low in total nitrogen (0.048 %) medium in available phosphorus (32.43 kg ha^{-1}) and fairly rich in available potash (350.00 kg ha^{-1}). Fifteen treatment combinations comprising of three methods of land configuration (flat bed (L_1), raised bed (L_2) ridge and furrow (L_3)) and five weed management treatments, viz., unweeded control (W_1), weed free upto harvest (W_2), two hand weedings + interculturing with hoe at 20 and 40 days after sowing (W_3), pre-emergence application of pendimethalin @ 1.00 kg a.i. ha^{-1} (W_4), and pre-emergence application of oxyfluorfen @ 0.24 kg ha^{-1} (W_5) were

evaluated on blackgram cv. T-9 by employing factorial randomized block design with three replications.

Among different methods of land configuration ridges and furrows method of land configuration improved almost all the growth and yield attributes positively which reflected in higher seed (1116.33 kg ha^{-1}) and haulm (2231.87 kg ha^{-1}) yield of blackgram. Moreover, net profit of Rs. 13104.90 ha^{-1} with net C.B.R. of 1:2.08 was also received under this treatment.

Almost all the growth and yield attributes were significantly influenced by various weed management treatments. The highest seed (1158.37 kg ha^{-1}) and haulm (2223.56 kg ha^{-1}) yield were recorded under treatment weed free upto harvest (W_2) closely followed by treatment of two hand weedings + interculturing with hoe at 20 and 40 DAS (W_3) and pendimethalin @ 1.00 kg a.i. ha^{-1} (W_4).

Treatments, viz., two hand weedings + interculturing with hoe at 20 and 40 DAS and application of pendimethalin @ 1.00 kg a.i. ha^{-1} found most effective with the lowest 280.90 and 377.30 kg ha^{-1} dry weight of weeds and higher weed control efficiency of 80.35 and 73.60 per cent, respectively.

The maximum and minimum nutrient removal by seed and haulm were recorded under treatments weed free upto harvest and unweeded control, respectively. The highest removal of nutrients by seed (39.34 and 5.07 kg NP ha^{-1}) and haulm (16.94 and 2.81 kg NP ha^{-1}) recorded under treatment of two hand weedings + interculturing with hoe at 20 and 40 DAS. Whereas the lowest nutrient removal (4.87 and 1.41 kg NP ha^{-1}) by weeds were also noticed under this treatment. Similarly the highest protein content (21.04 %) and protein yield (245.89 kg ha^{-1}) were recorded with treatment of weed free upto harvest followed by treatment of two hand weedings + interculturing with hoe at 20 and 40 DAS and application of pendimethalin @ 1.00 kg a.i. ha^{-1}.

The highest net profit of Rs. 12296 ha^{-1} was obtained from treatment of two hand weedings + interculturing with hoe at 20 and 40 DAS followed by treatments weed free upto harvest (Rs. 11731 ha^{-1}) and application of pendimethalin @ 1.00 kg ha^{-1} (Rs. 11574 ha^{-1}) while the highest cost benefit ratio (1:2.09) was obtained under treatment of two hand weedings + interculturing with hoe at 20 and 40 DAS followed by application of pendimethalin @ 1.00 kg a.i. ha^{-1} (1:1.78) and weed free upto harvest (1 :1.66).

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CERTIFICATE

This is to certify that the thesis entitled **"RESPONSE OF BLACKGRAM (*Phaseolus mungo* L. Hepper) TO LAND CONFIGURATION AND WEED MANAGEMENT PRACTICES UNDER SOUTH GUJARAT CONDITIONS"** submitted by Shri. **Vikramsingh Shivsingh Rathore** in partial fulfilment of the requirements for the award of the degree of **Master of Science (Agriculture)** in **Agronomy** of the **Gujarat Agricultural University** is a record of bonafied research work carried out by him under my guidance and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

Place : Navsari

Date : 23rd August, 2002.

(H. S. DAMAME)

DECLARATION

This is to declare that the whole of the research work reported in the thesis in partial fulfilment of the requirements for the degree of **Master of Science (Agriculture)** in **Agronomy** by the undersigned is the result of investigations done by me under direct guidance and supervision of **Dr. H.S. Damame** Associate Professor Department of Agronomy N.M. College of Agriculture Gujarat Agricultural University Navsari Campus, Navsari and no part of the work has been submitted for any other degree so far.

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Place : Navsari

Date : 23rd August 2002

Singh

(V. S. RATHORE)

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INTRODUCTION

I INTRODUCTION

With the current food grain production standing at about 200 million tonnes, India needs to produce an additional 5-6 million tonnes of food grains annually in the next decade to meet the requirement of an estimated population of nearly 1120 million by 2010 AD (Anon., 2000).

India is considered as the homeland of most of the grain legumes and the lion share of protein is supplied by pulses to majority of Indians. Pulses play a vital role in an Indian diet, as vegetable protein is an essential supplement to cereal based diet. The per capita availability of pulses in India is 34 g/day in 1998, now it is belived that availability of 55 g/day/capita would be sufficient to meet dietary protein requirement (Ali and Mishra, 2000). Pulses also provide excellent nutritive fodder and grain concentrates to the feeding animals. Pulses are known to improve soil fertility as they fix atmospheric nitrogen by symbiotic nitrogen fixation with the help of bacterium called Rhizobia. In India, pulses are grown in an area of 25.6 million ha (Swaminathan, 2000) with production of 15.89 million tonnes (Siddiq, 2000).

Among all the pulses, blackgram (*Phaseolus mungo* L. Hepper) is a highly prized pulse for its biological protein value and rich in phosphoric acid. It contains about 220 to 250 g protein/kg grain, 0.43% lysine, 0.07 triptophane and 0.09% methionine which are having good amino acid balance (Raju, 1984).

Blackgram occupies an area of 3.15 million hectares having total production of 1.49 million tonnes with productivity of 473 kg ha^{-1} (Anon., 1999). In India, major blackgram producing states are Andhra Pradesh, Madhya Pradesh, Bihar, Maharashtra, Uttar Pradesh, Tamil Nadu, West Bengal and Gujarat. Gujarat occupies an area of 1.252 lakh hectares having total production of 0.752 lakh tonnes with productivity of 601 kg ha^{-1} during *kharif* season (Anon., 2000). In Gujarat, the major blackgram producing districts are Sabarkantha, Panchmahal, Vadodara, Mehsana and Bharuch, where, it is extensively grown as an intercrop.

There is vast scope for increasing production per unit area by adopting the improved seeds of high yielding varieties coupled with suitable agronomic practices like proper method of sowing, use of optimum quantity of fertilizers, seed inoculation, proper irrigation schedules and weed control etc.

Poor soil management is one of the major factors responsible for the low productivity of crops. The germination and penetration, development and proliferation of roots in the soil are dependent on the physical conditions of the surface soil, looseness and friability of the soil, absence of soil crusting etc. can be achieved by soil configuration. Therefore, land configuration also play a vital role for easy and uniform germination. If land is not cultivated at proper time, it will form clods under dry conditions. Moreover, for irrigating the crop at critical crop growth stages, suitable method of sowing should be adopted for smooth irrigation, otherwise it will affect the germination and plant growth as well. Pulse crops are very sensitive to water logging and results in heavy plant mortality under high rainfall conditions. Sowing the crop on ridges under such situation is found advantageous as compared to flat bed sowing. Ridge sowing of pulses is desirable practice as it provides better aeration, root development and at the same time protects the crop from water logging condition (Srivastava *et al.*, 1984). In high rainfall areas seedling emergence is better when sown on ridges (90.99%), followed by sowing on raised bed (78.79%) and flat bed sowing (58.71%) (Chatterjee and Roquib, 1977). In India blackgram is usually sown on flat bed by seed drill or hand dropping, several research workers have indicated that manipulation of sowing method provides better environment of germination, growth, flowering and pod development which eventually increase the yield.

Weed management is one of the most serious problem in modern intensive farming, as the total loss of yield with increase in cost of cultivation could cause a greater economic loss. Weeds being naturally hardy in nature always offer severe competition in early stage of crop growth and cause considerable reduction in the crop yield. Crop yield losses due to weeds have been estimated to the extent of 65 per cent (Gogoi *et al.*, 1991). Weeds not only compete for nutrients, moisture, light and space but also increase the cost of cultivation and makes harvesting and threshing operations difficult.

Though hand weeding is the most effective, it is time consuming and costly. Besides unavailability of labourers at critical period makes timely operations difficult, resulting in reduction of yield. In these circumstances, chemical weed control is feasible through pre and post emergence application for timely eliminating the weeds.

In view of above considerations, the present study has been undertaken during *kharif* 2001 at the College Farm of Gujarat Agricultural University, Navsari with the following objectives.

1. To find the effect of land configuration on growth and yield of blackgram.
2. To find out the effect of weed management methods on growth and yield of blackgram.
3. To study the interaction effect of land configuration and various weed management methods.
4. To work out the economics of blackgram under various methods of land configuration and weed management methods.

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

The production potential of any crop depends upon number of interacting factors such as land configuration, weed management, fertilizer management and agro-climatic conditions prevailing at a particular place.

The research work pertaining to the effect of different methods of land configuration and weed management for blackgram and other pulse crop in India and abroad have been reviewed in this chapter under the following heads.

2.1 Effect of land configuration

2.2 Effect of weed management

2.3 Interaction effect

2.1 Effect of land configuration

Suitable planting method is one of the approaches adopted for improving the blackgram productivity, Land management system plays a major role in maximizing the infiltration, minimizing soil erosion and improving water use efficiency of field crops. ICRISAT, Hyderabad has developed a technique of preparing broad bed and furrows which conserve moisture as well as facilitates drainage of excess water during the period of heavy rainfall and was found appropriate in vertisols (Anon., 1985)

2.1.1 Effect on growth and growth attributes

Shrivastava and Pahalwan (1972) compared two methods of sowing of soybean on a clay loam soils at Jabalpur (M.P.) and observed that sowing on ridges produced taller plants as compared to flat bed sowing.

Bajpai and Malik (1976) studied the different methods of sowing at Jabalpur (M.P.) on clay loam soil. They reported that sowing on ridges (50 cm apart) produced more number of branches and nodules per plant of groundnut as compared to flat beds.

The studies conducted at Parbhani on vertisols on summer groundnut by Rasve *et al.* (1983) showed no significant difference in number of root nodules per plant with flat bed and ridges and furrows method of cultivation.

While studying the effect of sowing methods on growth and yield of soybean, Meharsingh *et al.* (1986) reported that different sowing methods did not affect the plant height, but the number of branches per plant were significantly higher under ridges and furrows sowing as compared to other methods of sowing.

Hadvani (1990) conducted the experiment at Navsari on clayey soils during summer and observed that plant height, dry matter per plant and root nodules per plant of groundnut were significantly higher under ridge furrow method.

Lawand *et al.* (1993) conducted a field experiment at Parbhani and reported that plant height, number of branches, leaves per plant and stem diameter of cowpea were significantly increased due to ridges and furrows method of sowing as compared to flat bed method. Similar results were also observed by Lawand *et al.* (1994).

The cultivation of soybean on ridges and furrow system improved soil environment, allowing greater root and root nodule development and improving plant growth and development in term of increased plant height, leaf area, than that of flat bed method in albic soils of Heilogjing in China (Huliching *et al.*, 1994).

Zhaojiuzhou *et al.* (1995) reported an increase in plant height, leaf area index, and dry matter accumulation of soybean in ridge and furrow over flat bed method of planting of Mishan (China) on albic soil.

In the studies conducted at Jabalpur on vertisols, ridge planting with one or two rows of soybean found significantly superior over flat bed planting with respect to plant height, main root length, nodules per plant, (Jain and Dubey, 1998).

2.1.2 Yield and yield attributes

According to Swaminathan (1971) ridge bed sowing gave higher yield than flat bed sowing in Arher, Urad and Moong. The highest grain yield of Arher (28.5 q ha^{-1}), Urad (11.39 q ha^{-1}) and Moong (7.6 q ha^{-1}) were recorded with sowing on ridges whereas the lowest yield of Arhar (21.8 q ha^{-1}), Urad (7.6 q ha^{-1}) and Moong (4.8 q ha^{-1}) were recorded with flat bed sowing.

Shrivastava and Pahalwan (1972) reported that grain yield of soybean was significantly influenced due to method of sowing. The grain yield recorded by ridge and furrow methods of sowing was significantly superior over flat bed method. They also observed that number of pods per plant and 100-grain weight were not significantly affected due to method of sowing.

Studies conducted by Bajpai and Malik (1976) on method of sowing on groundnut on a clay loam soil at Jabalpur (M.P.) revealed that sowing on ridges (50 cm apart) produced more test weight consequently recorded the highest yield (27.8 q ha^{-1}) as compared to that of flat beds (21.56 q ha^{-1}) followed by ridge (23.06 q ha^{-1}) and sowing in furrows (21.17 q ha^{-1}). They further observed that groundnut grown on ridges and furrows produced heavier kernels, higher pod and haulm yields over the flat bed method cultivation.

Deev (1978) and Eckert (1990) reported that the ridge and furrow method recorded the higher seed yield of soybean over flat bed method of planting.

In soybean, ridges and furrows method of planting recorded higher seed yield (1.92 tonnes ha^{-1}) as compared to that bed method (1.81 tonnes ha^{-1}) in vertisols at Rome (Italy) Saxena (1978).

Durrov and Egorchenkov (1981) conducted an experiment at Khabarovsk region on meadow soils to study cultivation of soybean on ridges. They reported that the cultivation of soybean on ridges decreased weed population and gave average seed yields of 1.43 t ha^{-1} as compared with 1.16 t ha^{-1} on flat seed bed sowing.

Gupta *et al.* (1984) summarized the results of soil management for increasing crop production and recommended the land configuration i.e. ridges for soybean in vertisol.

Shah (1984) reported that pulse crops are very sensitive to water logging and results into very heavy plant mortality. Planting the crop on ridges under such situations was found advantageous as compared to normal planting on flat seed bed sowing.

Parameswaran *et al.* (1987) in a study on different moisture conservation techniques for rainfed groundnut, obtained higher pod yield with raised beds (1217 kg ha^{-1}) as compared to ridges (1063 kg ha^{-1}) and flat bed (974 kg ha^{-1}) methods.

Chauhan (1989) and Patel and Parmar (1989) from Anand reported that number of mature pods per plant, 100-kernel weight, shelling percentage and pod yield of groundnut remained unaffected due to different methods of planting.

Results of a trial conducted at Navsari on clayey soils during summer season revealed that number of pods per plant, test weight, pod yield, haulm yield and harvest index of groundnut were significantly higher in ridges and furrows method as compared to other methods of sowing (Hadvani, 1990).

Mohamed (1991) conducted an experiment at Shendi area (Sudan) to study the effect of planting methods on grain yield and yield components of chickpea. He observed that flat sowing method out yielded the sowing on ridges by 98.30 kg ha^{-1}.

Gus *et al.* (1994) reported that the ridging or thiseling in soybean increased 16-23 per cent seed yield over discing in clay alluvial soil at Transylvania (Romania).

Huliching *et al.* (1994) revealed that the cultivation of soybean on ridges and furrow system improved the soil environment, allowing greater root and root nodule development and improving plant growth and development which resulted in increased number of pods per plant, 100 seed weight and higher seed yield than that of flat bed method in albic soils of heliogjing in China.

Saikh *et al.* (1994) revealed that total dry matter production and grain yield of sunflower were significantly higher with sowing on ridges and furrow as compared to normal sowing.

Bheemapa *et al.* (1994) reported that a large per cent of farmers felt the favorable advantage of broad bed furrow method of cultivation over flat bed method in increasing the yield of groundnut crop.

Patel *et al.* (1995) conducted an experiment at Anand on loamy sand soils during summer season on groundnut and reported that the highest pod yield (1.90 t ha^{-1}) was recorded under furrow sowing and furrow irrigation method.

Zhaojiuzhou *et al.* (1995) observed that the higher pod number per plant, seed number per plant, 100-seed weight and seed yield of soybean in ridge and furrow over flat bed method of planting of Mishan (China) on albic soil.

Study conducted by Jayapaul *et al.* (1996) revealed that the yield of soybean grown in *Kharif* and summer was the highest in broad bed followed by ridges and control basin.

Sheikh and Mungse (1998) conducted a field trial and reported that ridges and furrows system of planting recorded significantly higher dry matter per plant and grain yield of chickpea as compared to flat bed sowing mainly due to significant increase in number of primary, secondary and tertiary branches per plant which resulted in increased fruiting nodes and thereby grain yield.

Patel *et al.* (2000) conducted a field experiment at S.K. Nagar during summer to study the response of groundnut to different methods of sowing in sandy soil of North Gujarat and reported that paired row at 30 cm apart of raised bed sowing having 45 cm width yielded significantly higher pod and haulm yield being at par with flat sowing at 30 and 45 cm with alternate furrow.

Desai *et al.* (2000) at Navsari during *kharif* season studied the effect of land configuration treatments on grain yield of pigeonpea. They reported that providing 1 furrow after 4 rows of pigeonpea recorded the highest grain yield (2.65 tonnes ha^{-1}) which was significantly superior to flat bed as well as ridge and furrow sowing.

Studies conducted by Ugale *et al.* (2000) at Rahuri (M.S.) revealed that higher number of pods and seed per plant were recorded under ridges and furrows over flat bed method of sowing in chick pea.

2.1.3 Economics

Chauhan (1989), while evaluating different sowing methods for groundnut at Anand, observed that higher net realization was obtained under ridges and furrows method as compared to flat bed method. Similarly, Hadvani (1990) reported the highest net profit in ridges and furrows method of sowing as compared to other methods.

Jain and Dubey (1998) revealed that the highest net return and benefit cost ratio was obtained in ridge planting as compared to flat bed planting.

2.2 Effect of weed management

Weed plants are always considered an unique hurdle in agriculture. High infestation of weeds especially at the early stage of crop growth, posses considerable threat in achieving the desired yield of any crop, here an attempt has been made to review the research work carried out on various aspects of weed management in blackgram crop under following heads.

2.3.1 Weed flora in blackgram crop

2.3.2 Losses caused by weeds in blackgram crop

2.3.3 Critical period of crop-weed competition

2.3.4 Effect of weed management practices on growth and yield of blackgram

2.3.4.1 Effect of mechanical methods of weed management

2.2.1 Weed flora in blackgram crop

Blackgram being a short duration crop, stands for about two and half to three months in the field. A large number of weed species varying in habit i.e. annual and perennial observed in blackgram fields are mainly influenced by adaphic, climatic and biotic factors. The literature pertaining to weed flora observed in the blackgram fields at various places is reviewed here.

Chin and Pandey (1991) working at IARI, New Delhi reported that weed species infesting the blackgram crop were *Trianthema peortulacastrum* L., *Digera muricata* (L.) Mart., *Portulaca oleracea* L., *Phyllanthus niruri* L. and *Celosia argentea* L. among dicot and *Dactyloctenium aegyptium* (L.) wild, *Leptochloa sinensis* L. and *Digitaria sanguinalis* (L.) Scop among monocot during the rainy season.

Raghvani *et al.* (1985) at Junagadh observed predominating weed flora in mungbean field during *Kharif* were *Cynodon dactylon, Panicum colonum, Cloris verigata, Celosia argentea, Convolvulus arvensis* and *cyperus odoratus*.

Tewari *et al.* (1990) at Kanpur observed the weed species comprising of *Cyperus rotundus* L., *Sorghum halepense* L., *Digitaria sanguinalis* L., *Phyllanthus niruri* L., and *Trianthema monogyna* in pigeonpea + blackgram inter cropping during summer season.

Gupta *et al.* (1990) at Hissar in summer season observed *Trianthema peortulacastrum* L., *Echinochloa colonum* (L.) link., *Cyperus rotundus* L., and *Cynodon dactylon* (L.) spp. in mungbean.

In field experiment on blackgram at Jorhat *Cynodon dactylon* (L.) Pers., *Ageratum conyzoides* L. *Borreria articularis* (L.f.) F.N. Williams and *Phyllanthus niruri* L. were the dominant weeds during *Kharif* (Gogoi *et al.*, 1991).

Weed flora observed in rainfed blackgram were *Digera arvensis*, *Celosia argentea*, *Commelina benghalensis*, *Eclipta alba*, *Phyllanthus niruri*, *Physalis minima*, *Leucas aspera*, *Euphorbia hirta Brachiaria ramosa*, *Cyperus irri*, *Cynodon dactylon Panicum colonum*, *Ageratum congzoide* and *Borrevia hispida*. The proportion of broad leaved weeds were higher than narrow leaved weeds (Gogoi *et al.* 1992).

De and Modak (1993) reported that predominant weeds viz., *Echinochloa colonum*, *Digitaria sanguinalis*, *Trianthema pertulacastrum*, *Amaranthus viridis* and *Cyperus rotundus* were infesting the blackgram field.

While studying weed management in urdbean during *Kharif* season Mishra and Singh (1993) reported that experimental field was infested with *Echinochloa* Spp., *Cyperus rotundus*, *Cleome viscosa*, *Celosia argentea*, *Cucumis trigonus*, *Eleusine indica* and *Physalis minima*.

Patro and Prusty (1994) at Berhampur (Orissa) revealed that the dominant weeds viz., *Cynodon dactylon*, *Echinochloa colona*, *Cyperus rotundus*, *Cyperus irri*, *Celosia argentea*, *Chenopodium album*, *Portulaca oleracea* and *Euphorbia hirta* were observed in mungbean during *Kharif*.

While studying at G.A.U., Navsari Arvadia *et al*. (1995) reported the predominant weed species in greengram experimental field during summer were *Echinochloa colonum*, L, *Cyperus rotundus*, L. and *Trianthema portulacastrum*. Almost similar weed flora were also observed by De *et al*. (1995) in blackgram at Sriniketan (West Bengal).

Singh *et al*. (1995) conducted a field experiment during summer seasons of 1991 and 1992 at Jabalpur (Madhya Pradesh) and observed that important weed species were *Chicorium intybus* *Commelina communis*, *Corchorus* Spp., *Chenopodium album*, in broad leaved weeds, *Echinochloa colonum*, and *Cynodon dactylon* among grasses and *Cyperus rotundus*, among sedges in mungbean. Almost similar weed flora was reported by Singh *et al*. (1996).

Jain *et al*. (1997) at Gwalior (M.P.) during rainy season revealed that weed species infesting blackgram were *Boerhavia diffusa* L., *Commelina benghalensis* L. *Trianthema portulacastrum* L. *Digera arvensis* Forskaal, *Phyllanthus niruri* L. *Cynodon dactylon* Pers., *Cyperus rotundus* L. and *Echinochloa crusgalli* Beauv. Almost similar weed species were also observed by Yadav and Shrivastava (1998).

Reddy *et al.* (1998) conducted a field experiment at Rajendranagar, Hyderabad (A.P.) and observed that the different weed species in greengram during *kharif* were *Cyperus rotundus, Panicum* spp., *Commelina benghalensis, Legasca mollis, Cellosia argentea, Cleome viscosa, Euphorbia geniculata, Parthenium hysterophorus, Amaranthus viridis* and *Trianthema portulacastrum*.

While studying at Raipur (M.P.) Choubey *et al.* (1999) reported that the predominant weeds present in the summer blackgram crop were *Digitaria sanguinalis* (L.) Scop., *Echinochloa colonum* (L.) Link, *Enhydra fluctuans* Lour., *Physalis minima* L. and *Cyperus iria* L.

2.2.2 Losses caused by weeds in blackgram crop

The simultaneous emergence and rapid growth of weeds, leads to severe reduction in the growth and ultimately in yield of crop.

Vats and Sidhu (1976) reported yield reduction to the extent of 50 per cent in mungbean during rainy season due to severe competition by weeds in early crop stage.

Dhingra *et al.* (1984) at Ludhiana observed that unchecked weeds reduced grain yield by 48.3 per cent in mungbean.

Gogoi *et al.* (1991) at Jorhat reported 65 per cent reduction in yield of blackgram due to weeds during *kharif* season.

De and Modak (1993) conducted a field experiment at Sriniketan (West Bangal) and showed that there was 38 per cent yield reduction due to weeds in summer blackgram (cv. B-76). Similar results were also reported by Mishra and Singh (1993).

Weeds caused 66.7 per cent reduction in greengram yield during *kharif* season at Berhampur in Orissa (Patro and Prusty, 1994).

A field experiment at Pantnagar (U.P.) revealed the reduction in yield to the tune of 64.8 per cent due to weeds in greengram during summer season (Singh *et al.*, 1999).

Patel *et al.* (2000) conducted an experiment at GAU, Anand (Gujarat) and reported that the reduction in greengram yield under unweeded control due to weed competition was 29.6 per cent.

2.2.3 Critical period of crop weed competition

Weeds being naturally hardy and emerge faster, cause severe competition in respect of light, nutrients, water and space reflecting in considerable reduction in crop yield at an early stage of crop.

Raghvani *et al.* (1985) suggested that the first 30 days after sowing can be considered as the critical period of weed competition in mungbean during *kharif* season.

Kumar and Kairon (1990) found first 30 days are the most critical period for crop weed competition in greengram.

Critical period of crop weed competition in *kharif* blackgram (cv. T-9) was between 10 and 30 days after sowing (Gogoi *et al.*, 1992).

Singh *et al.* (1996) concluded that initial 45 days period can be considered as the critical period with respect to crop weed competition in mungbean.

2.4 Effect of weed management practices on growth and yield of blackgram

From the earliest period of the history, man is battling with weeds because they interfere with agricultural operations, increases the cost of cultivation and reduces the yield of crops. Starting with hand, man has used stone tools, hand tools, bullock and tractor drawn implements, chemicals, integrated approach etc. as the advancement of agriculture.

2.2.4.1 Effect of mechanical method of weed management

Mechanical methods of weed management are more common, effective and easy but time and labour consuming, more expensive and not feasible during every stages of crop growth.

Vats and Sidhu (1976) conducted an experiment during *kharif* revealed that number of branches and pods per plant significantly influenced by various weed treatments.

Raghvani *et al.* (1987) conducted an experiment at Junagadh (Gujarat) reported that the highest grain yield (1222 kg ha^{-1})

of blackgram was obtained under the treatment of two hand weeding alongwith two interculturing during *kharif*.

Kumar and Kairon (1990) conducted a field experiment at agronomy research farm of Haryana Agricultural University, Hissar and reported that weeding with the help of hand-hoe at 30 or 40 DAS maximized the grain yield of summer mungbean.

While working at Jorhat, Gogoi *et al*. (1991) observed that grain yield of blackgram was significantly affected by different weed management treatments. Hand weedings twice at 20 and 40 DAS recorded the highest grain yield by suppressing the weed growth.

Singh and Choudhary (1992) conducted a field experiment at Jobner (Rajasthan) and found that two hand weedings at 20 and 40 DAS increased 65 per cent yield of greengram during *kharif* season.

Singh *et al*. (1992) at Sehore (Madhya Pradesh) reported that yield as well as yield attributes of blackgram during *kharif* season were significantly affected by different weed control treatments. They observed that yield and yield attributes viz., pods per plant, seed per pod and 1000-grain weight (g) were significantly improved under weed free conditions. Treatments of two hand weedings at 15 and 30 DAS alongwith two spot weedings followed by hand weeding at 30 DAS gave significantly higher grain yield as compared to control.

Jain *et al*. (1997) at Gwalior (M.P.) observed that cultural treatment i.e. two hand weedings at 20 and 40 DAS found effective in controlling major weed flora in blackgram and recorded improvement in yield attributes (pods per plant, seed per pod, grain weight per plant and pod length) and weed control efficiency which resulted into higher seed yield.

A field experiment conducted at Charoli (Assam) revealed that hand hoeing at 20 DAS gave the highest grain yield of blackgram during rainy season (Bayan and Gogoi, 1998).

2.2.4.2 Effect of chemical method of weed management

Non-availability of sufficient labourers for timely weeding, particularly near industrial areas and difficulty in manual weeding under certain conditions pose serious problems coupled with the increased labour cost emphasize the use of economically viable weed control practice and it is therefore, imperative to find out alternative and cheaper means for controlling weeds.

From the results of the experiment, Jain and Jain (1987) at Mandsaur reported that higher grain yield of blackgram was registered with pendimethalin @ 1.5 kg a.i. ha^{-1} and terbutryn @ 0.5 kg a.i. ha^{-1} which were comparable with hand weeding and improved method (weeding with khurpi at 15 DAS and kolpa at 30 DAS).

Singh and Rao (1992) reported that pre-emergence application of oxyfluorfen @ 0.10 kg a.i.ha^{-1} recorded 893 kg ha^{-1} grain yield of mungbean during monsoon season, which was comparable with hand weeding treatment (1021 kg ha^{-1}).

Singh and Choudhary (1992) conducted a field experiment at Jobner (Rajasthan) and reported that pendimethalin @ 1.0 kg a.i. ha^{-1}

increased the grain yield of greengram which was statistically comparable to that of two hand weedings at 20 and 40 DAS.

Pendimethalin @ 1.0 kg ha^{-1} gave higher grain yield (1256 kg ha^{-1}) of greengram which was comparable to hand weeding at 20 and 40 DAS (1289 kg ha^{-1}). Both the treatments were superior over unweeded control during summer season (Arvadia *et al.*, 1995).

Jain *et al.* (1997) conducted a field experiment at Gwalior (M.P.) and reported that pendimethalin @ 0.75 kg a.i. ha^{-1} increased the number of branches and number of leaves per plant as compared to weedy check.

Ramanathan and Chandrashekharan (1998) observed that pre-emergence application of pendimethalin @ 1.5 kg a.i. ha^{-1} followed by one hand weeding at 30 DAS resulted in higher weed control efficiency, maximum number of pods per plant, seed yield and net return in blackgram.

2.2.4.3 Effect of integrated method of weed management

Integrated approach of weed management involves the use of two or more weed management techniques at a time, which are generally, selected, from five general categories viz; preventive, biological, cultural, mechanical (physical) and chemical in well planned sequence without or little disturbing the eco-system. The integrated weed management approach is advantageous because it is very difficult to control all weeds through out season by any one technique in a particular crop however if this is possible, there is every possibility of surviving few species which can produce sufficient number of weeds to perpetual in the field in subsequent season/years.

Patel and Patel (1989) reported the highest plant height of 7.7 cm and 15.9 cm of field bean and cowpea, respectively under weed control treatment of fluchloralin @ 0.9 kg ha^{-1} + weeding at 40 DAS.

While working at Berhampur (Orissa), Patro and Prusty (1994) revealed that weed free plot recorded the highest grain yield (9 q ha^{-1}) and was found at par with the use of pendimethalin @ 0.75 kg ha^{-1} followed by hoeing or weeding at 30 DAS and twice hoeing and weeding at 20 and 30 DAS in mungbean during *kharif* season.

De *et al.* (1995) working at Sriniketan found that integration of chemicals with physical method of weed control produced more pods per plant, seed and stover yield in blackgram during summer season.

Mishra and Misra (1995) conducted a field experiment at Bhubaneshwar (Orissa) reported that different weed control methods significantly influenced the grain yield of summer blackgram. The highest grain yield was recorded under weed free conditions, followed by chemical + mechanical method and farmers practice (twice hoeings and weedings at 15 and 30 DAS).

Studies conducted by Modak *et al.* (1995) at Sriniketan (West Bengal) revealed that all the weed control treatments significantly reduced the weed biomass and increased the yield of blackgram as compared to control. Combination of hand weeding and pendimethalin (1.0 kg ha^{-1}) resulted into decrease in weed biomass and increased the yield. Similar results were also reported by Jain and Jain (1987).

While working at Pantnagar (Uttar Pradesh), Singh *et al.* (1999) found that pendimethalin @ 1.0 kg ha^{-1} + one hand weeding at 20 DAS, pendimethalin alone and two hand weedings (20 and 40 DAS) and plots kept weed free being at par with each other produced significantly higher grain yield as compared to weedy check in summer mungbean.

2.2.5 Effect of weed management on nutrient uptake by crop and weeds.

Tewari *et al.* (1990) reported that the highest removal of N, P_2O_5 and K_2O through weeds was noted under weedy check whereas the minimum removal under weed free conditions in pigeonpea-blackgram intercropping system.

Modak *et al.* (1995) at Sriniketan (West Bengal) reported that frequent weeding resulted in lowest uptake of nitrogen by weeds. The nitrogen uptake by blackgram crop under frequent weedings was observed maximum and statistically superior to all other treatments. They also observed that all combinations of herbicide and hand weeding gave better nitrogen uptake by blackgram as compared with herbicide alone.

While working at Kharagpur (West Bengal), Choubey *et al.* (1999) observed that adoption of weed management practices significantly enhanced NPK uptake by blackgram and reduced removal of nutrients by weeds as compared to that of unweeded check with saving of 29.1 to 52.3 per cent N, 26.8 to 56.6 per cent P and 16.9 to 54.3 per cent K.

2.2.6 Economics

Patro and Prusty (1994) at Berhampur (Orissa) observed that maximum benefit cost ratio of 0.95 was achieved under weeding at 20 and 35 DAS in mungbean during *Kharif* season.

Weeds caused a loss of Rs. 2431 ha^{-1} in blackgram. The most profitable weed management treatments were hand weeding twice followed by pre-emergence application of alachlor @ 1.0 and 0.5 kg ha^{-1} in blackgram (De *et al.*, 1995).

Mishra and Misra (1995) found that the net profit and net return per rupee invested was the highest with chemical + mechanical method in summer blackgram. Almost similar results were also observed by Mishra and Misra (1997).

Raj *et al.* (2000) at Navsari found that the maximum net realization (Rs. 12962 ha^{-1}) was recorded under treatment weed free condition upto harvest while the maximum cost benefit ratio of 1:4.03 was observed under hand weeding at 20 DAS.

2.3 Interaction effect

Khade *et al.* (1997) conducted an experiment at Dapoli (MS) on clay loam soils during *rabi* season, to study the effects of irrigation schedules, planting layouts and weed management on the yield of summer groundnut sown on broad bed and furrow and maintaining weed condition throughout the growth period of groundnut proved significantly superior in increasing dry pod yield. However, the crop planted on broad bed and furrow and kept weed free gave maximum net return (Rs. 11640/ha) and highest benefit cost ratio (2.41).

Singh *et al.* (1998) conducted an experiment at Pantnagar (U.P.) on sandy loam soil during rainy season, to study the effect of planting method and weed control practice on weed management and productivity of pigeonpea in foothills region. They observed that the pigeonpea sowing on ridges or on raised beds significantly increased plant stand at harvest, pods/plant and grain yield/ha and reduced weed biomass. The 100-seed weight remained unaffected by different planting methods and hand weeding with the help of sickle 30 days after planting, or alchlor (2 kg ai./ha as pre-emergence). Application significantly increased the grain yield over weedy check.

MATERIAL AND METHODS

III MATERIALS AND METHODS

Details of techniques and materials used during the course of investigation on, “Response of Blackgram (*Phaseolus mungo* L. Hepper) to land configuration and weed management practices under South Gujarat conditions” are described here.

3.1 Experimental site

An experiment was conducted on plot no. D-15 of the college farm, Gujarat Agricultural University, Navsari during the *Kharif* 2001. The experimental field during the course of experiment was fairly levelled and uniform.

3.2 Climate and weather conditions

Geographically, the college farm, Gujarat Agricultural University, Navsari Campus Navsari is situated at 20° 57’ North latitude and 72°54’ East longitude with an altitude of 10 meters above mean sea level.

The climate of this area is typically tropical characterized by fairly hot summer, moderately cold winter with humid and warm monsoon. The rainfall of this region is heavy and normally commences from the second fortnight of June and ends by the middle of September. Pre-monsoon rains in the last week of May or in the first week of June are not uncommon. Most of the precipitation is received from South-West monsoon concentrating in the months of July and August. The annual mean rainfall received during the monsoon season was 1210.4 mm distributed in 50 rainy days and grouped under South Gujarat heavy rainfall zone.

The winter season sets in usually towards the end of October. The temperature starts decline in first fortnight of November and becomes the lowest either in the months of December or January and hence, these two months are the coldest months of a season.

The summer commences from middle of February and prolongs upto first fortnight of June. From February onwards, the temperature starts rising and reaches the maximum in the months of April and May which are the hottest months of the year.

The week wise meteorological data on maximum and minimum temperature, relative humidity and sunshine hours and rainfall during the period of experimentation recorded at the meteorological observatory of the College Farm, N.M. College of Agriculture, Gujarat Agricultural University, Navsari Campus, Navsari are presented in Table-1 and graphically depicted in Fig. 1.

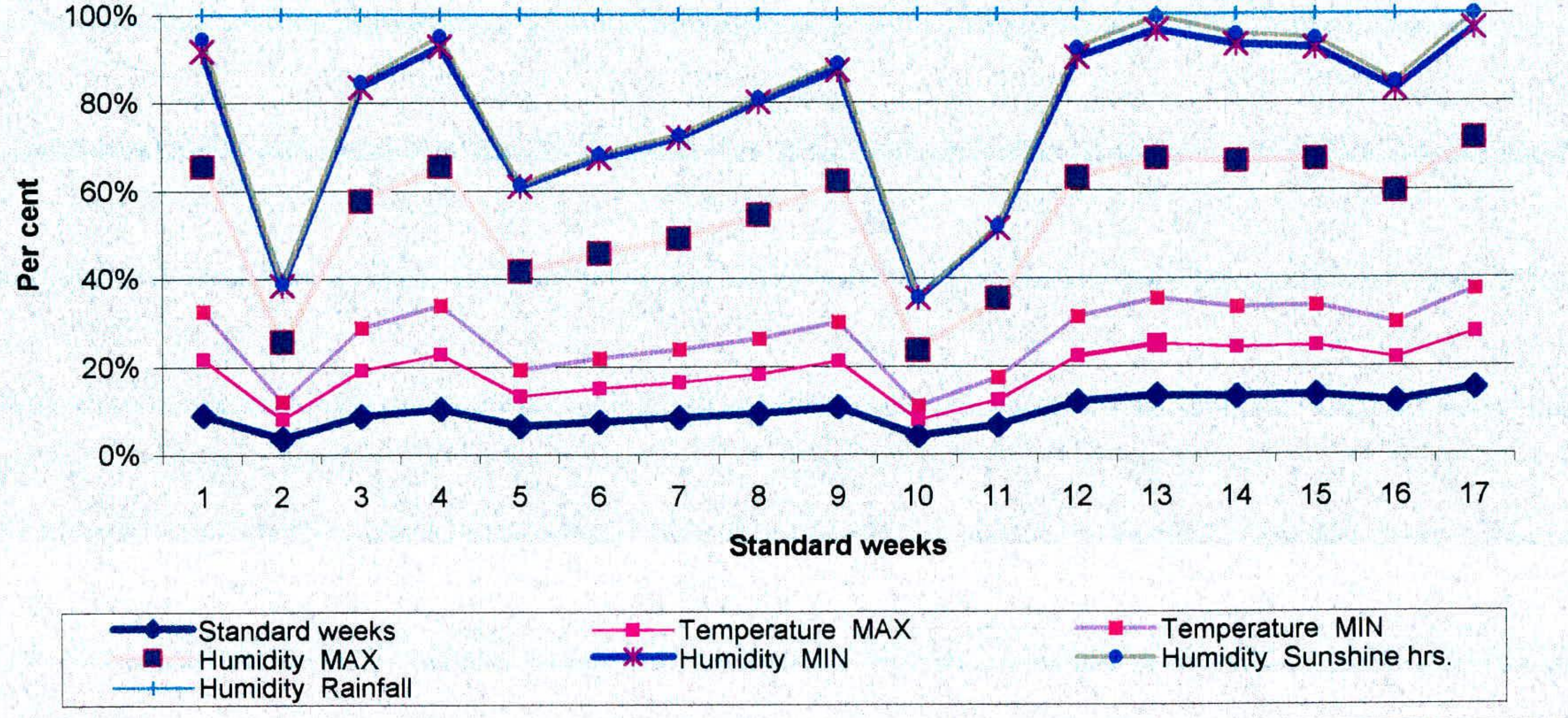
3.3 Physio-chemical properties of soil

The soil of the College Farm has been placed under the group of Ustochrepts, Sub group of verti Ustochrepts Sub order orchrepts and order inceptisols with Jalalpur Series and classified as "Deep Black Soils" moderately drained having good water holding capacity. It also cracks heavily on drying and expands on wetting. The pre-dominant clay mineral is montmorillonite.

Table 1 : Mean weekly meteorological data recorded at the meteorological observatory of GAU, Navsari From June 2001 to Sept 2001

Month and year	Standard week	Temperature (°C)		Relative humidity (%)		Sunshine hrs.	Rainfall (mm)	Rainy days
		Max.	Min.	Max.	Min.			
June 01	23	32.4	27.5	84	67	7.1	14.0	2
	24	29.0	26.0	89	85	2.4	403.0	5
	25	30.3	27.7	83	75	3.6	44.0	1
	26	31.5	28.0	80	69	6.1	12.1	2
May 01	27	28.6	25.7	94	81	2.1	162.6	5
	28	28.8	26.0	90	82	3.6	120.0	6
	29	28.4	26.1	88	81	1.8	96.1	6
	30	28.8	26.0	91	83	3.4	61.3	6
	31	29.8	25.4	92	73	4.6	32.0	4
Aug. 01	32	27.1	25.1	96	92	0.6	494.0	7
	33	28.7	25.8	90	80	3.4	241.2	3
	34	29.5	25.6	90	78	5.9	22.2	2
	35	30.2	26.7	83	76	7.9	1.5	0
Sept. 01	36	30.6	25.1	91	73	6.5	12.6	1
	37	30.6	24.8	91	69	6.4	15.0	1
	38	30.9	25.5	94	74	5.6	48.6	2
	39	32.6	25.4	89	65	8.8	-	0

Fig. 1 : Mean weekly meteorological data recorded at the meteorological observatory of GAU, Navsari From June 2001 to Sept 2001



Soil samples were collected randomly from selected spots to a depth 0-30 cm covering entire area of experimental field before introduction of treatments. The samples were mixed thoroughly and composite sample was prepared and then analysed for various physical and chemical properties of the soil.

The mechanical analysis was done by international pipette method (Piper, 1950).

Total nitrogen estimation was carried out by the modified kjeldahls method (Jackson, 1967).

Available phosphorus was determined by metavenadate method (Olsen *et al.*, 1954), while the available potassium was estimated by flame photometrically (Jackson, 1967), pH by glass electrode pH meter, electrical conductivity by conductivity bridge and organic carbon by Walkley and Black's method (Jackson, 1967). The relevant results obtained are presented in Table-2.

The data presented in Table-2 on soil analysis revealed that the soil of experimental plot was clayey in texture. The soil reaction was alkaline. The chemical analysis of experimental plots indicated that the soil was low in nitrogen (0.48 %), medium in organic carbon (0.49 %) and available phosphorus (32.43 %) but rich in available potash (350 kg ha^{-1}).

3.4 Cropping history

The cropping programme of the experimental plot followed in the preceding three years is presented in Table-3.

Table 2 : Physico-chemical properties of experimental soil

Soil characteristics	Values from 0-30 cm depth	Methods employed for determination
A. Physical properties		
Sand (%)	13.40	
Silt (%)	19.15	International pipette method (Piper, 1950)
Clay (%)	67.45	
Textural class	Clayey	
B. Chemical properties		
Soil pH (1 : 2.5 soil : water ratio)	7.8	Potentiometric pH meter (Jackson, 1967)
Electrical conductivity (dSm^{-1} at 25°C) (1 : 2.5 soil : water ratio)	0.35	Schofield method (Gaur, 1967)
Organic carbon (%)	0.49	Walkley and Back's rapid titration method (Jackson, 1967)
Total nitrogen (%)	0.048	Modified kjeldahal's method (Jackson, 1967)
Available P_2O_5 (kg ha^{-1})	32.43	Olsen's method (Jackson, 1967)
Available K_2O (kg ha^{-1})	350.00	Flame photometerically (Jackson, 1967)

Table 3 : Cropping history of the experimental field

Year	Season	Crop
1998-1999	*Kharif*	Brinjal
	Rabi	Chilli
	Summer	Okra
1999-2000	*Kharif*	Pigeon pea
	Rabi	Gram
	Summer	Fallow
2000-2001	*Kharif*	Brinjal
	Rabi	Gram
	Summer	Soybean
2001-2002	*Kharif*	(Present investigation on blackgram)

3.5 Experimental details

The details of the experiment are given as under.

3.5.1 Details of layout

The treatment details along with symbols used in the layout plan are as follows.

(i) Design : Factorial Randomized Block Design

(ii) No. of replications : Three

(iii) Treatments : Fifteen :- As per details given under

(A) Land configuration (L)

L_1 = Flat bed method

L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)

L_3 = Ridges and furrows

(B) Weed management treatments (W)

W_1 = Unweeded control

W_2 = Weed free upto harvest

W_3 = Two hand weedings + interculturing with hand hoe at 20 and 40 days after sowing

W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}

W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}

(iv) Total No. of plots : 45

(v) Plot size : Gross : 4.5m x 3.6m

Net : 3.5m x 2.7m

(vi) Spacing : Between rows = 45 cm

Within rows = 10 cm

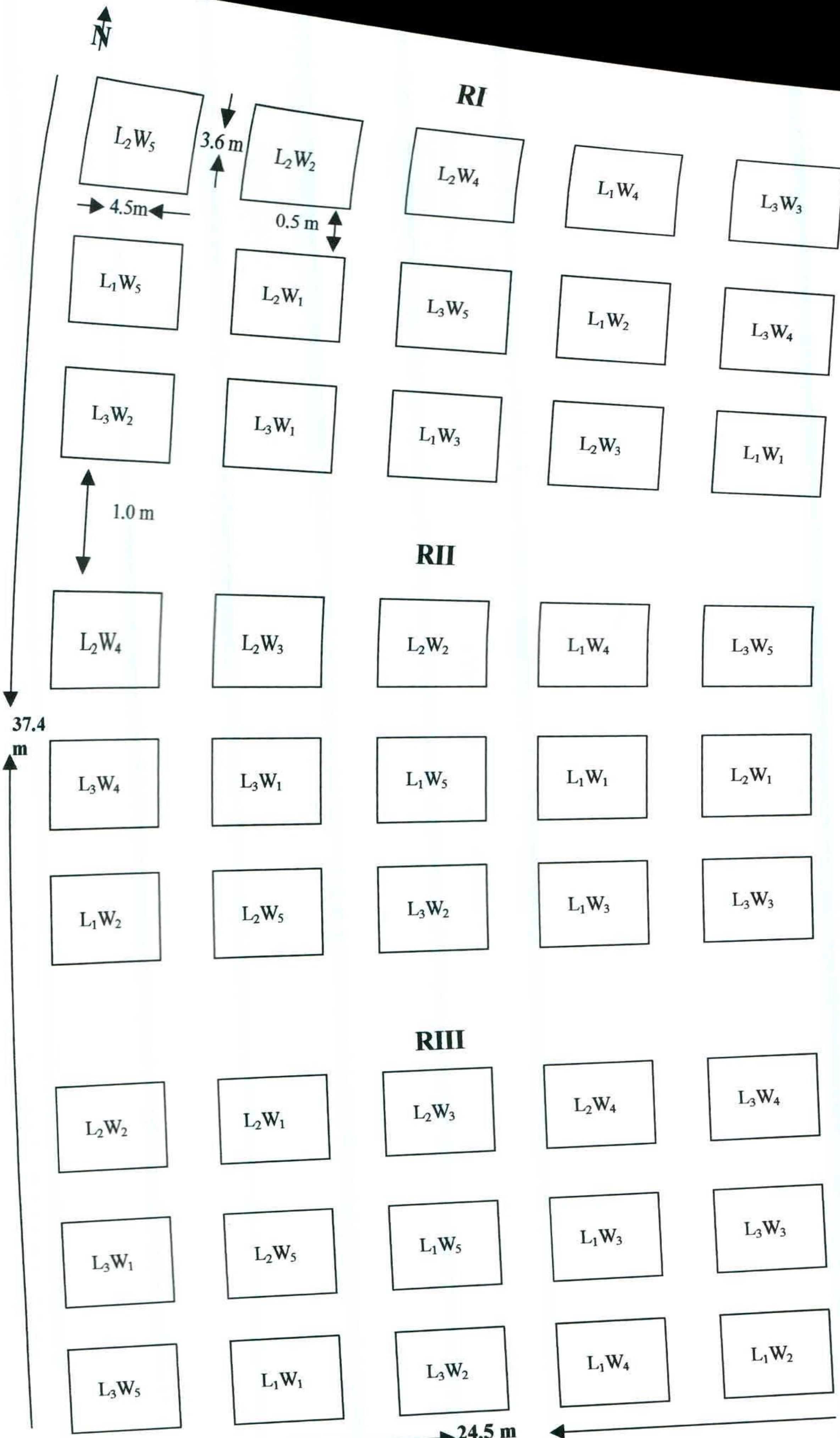


Fig. :- 2 Plan of layout

(vii) No. of rows per plot : Gross plot = 8 rows
Net plot = 6 rows

(viii) Total experimental area : 916.3 Sq.m.

(ix) Crop and Variety : Blackgram cv. T-9

(x) Direction of sowing : North-South

(xi) Date of sowing : 13th June, 2001

3.5.2 Salient feature of the variety

The present investigation was carried out by using "T-9" variety of Blackgram. This variety was evolved in Maharashtra. It is a short duration variety that matures in 75 to 80 days also dwarf, photo-insensitive and suitable for all seasons, i.e. *kharif*, *rabi* and summer. It is a variety with greater plasticity, highly adaptable throughout the country.

3.5.3 Chemical properties of herbicides

3.5.4.1 Pendimethalin

Pendimethalin is a pre-emergence/pre-sowing selective herbicide, used for controlling most of the annual grasses and broad leaved weeds. Its persistency prolongs for a period of 45 to 60 days in the soil and then degraded. It is an orange yellow crystalline solid with melting point of 56-57°C, vapour pressure 3 x 10^5 mm Hg at 25°C. Its solubility at 20°C is 0.3 mg/l water, soluble in chlorinated hydrocarbons and aromatic solvents. It is stable to alkaline and acidic soil conditions and non-corrosive. This herbicide somewhat volatile in nature hence incorporation is needed when applied in the soil. It acts by inhibiting early seedling development of susceptible species. It gives economical weed control for about three months after its application and degrades before next crop sown.

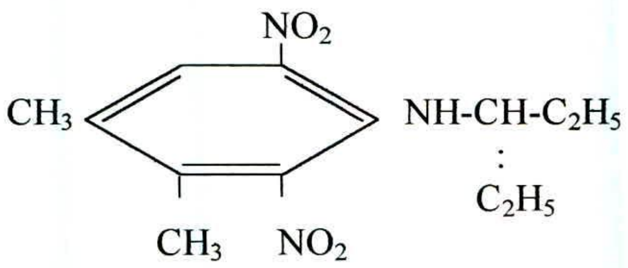
1. Name : N-(1-ethylpropyl)-3,4-dimethyl-2,

   6-dinitrobenzeneamine

2. Common Name : Pendimethalin

3. Trade Name : Stomp/Prawl/Accotab/Penoxilin/Herbadox

4. Structural formula



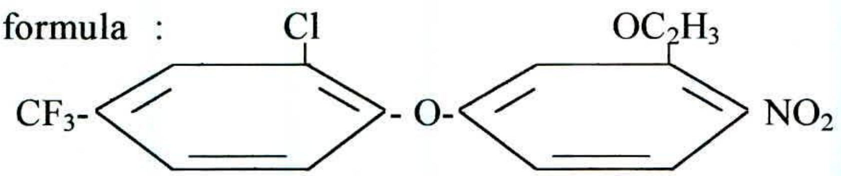
5. Chemical formula : $C_{13}\ H_{19}\ N_3\ O_4$
6. Formulation : Emulsifiable concentrate 30 per cent
7. LD_{50} : 1250 mg kg^{-1} for rats
8. Rate of application : 0.75 to 1.5 kg a.i. ha^{-1}
9. Appearance : Crystalline orange yellow solid

3.5.4.2. Oxyfluorfen

Oxyfluorfen is belonging to ether compound group of herbicides. It is pre and post-emergence herbicide. As pre-emergence herbicide, it is selective to potato, onion, rice, maize and certain pulses, oilseeds and spices. As post-emergence herbicides, it is used in orchards, plantation crops, and no-till planting system and in non-cropped areas.

It enhances the respiration in susceptible plans, damages their cell membranes and disturbs their photosynthetic and phosphorylation mechanisms.

1. Name : 2-Chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(Trifluromethyl) benzene
2. Common Name : Oxyfluorfen
3. Trade Name : Goal, Gold
4. Structural formula :



5. Formulation : Emulsifiable concentration 23.5 per cent and granular
6. LD_{50} : 5000 mg kg^{-1} for rats
7. Rate of application : 0.05 to 0.5 kg a.i. ha^{-1}

3.6 Field operations

The schedule of pre and post sowing operations carried out during the investigation are presented in Table-4.

3.6.1 Pre-sowing operations

3.6.1.1 Preparation of land

The experimental field was prepared by a ploughing followed by application of FYM @ 10 t ha^{-1} and by disking twice by

Table 4 : Calendar of important field operations

Sr. No.	Field operations	Date of operation
(A) Pre-sowing operations		
1.	(a) Ploughing	7/6/2001
	(b) Disking and planking by tractor	8/6/2001
2.	Lay out of experiment	10/6/2001
3.	Preparation of seedbed	12/6/2001
4.	Fertilizer application	13/6/2001
(B) Sowing and post-sowing operations		
1.	Sowing	13/6/2001
2.	Spraying of pre-emergence herbicides	14/6/2001
3.	Gap filling	29/6/2001
4.	Thinning	29/6/2001
5.	Weeding and interculturing	As per treatment Schedule
6.	Irrigation	**No irrigation**
7.	Plant protection measures	**As and when required**
8.	Harvesting	8/9/2001
9.	Threshing and cleaning	10/9/2001

tractor drawn implements. The plaking was done by tractor drawn plank in both the directions to obtain a good tilth. For sowing, flat beds raised beds and ridges and furrows were prepared manually as per land configuration treatments.

3.6.1.2 Fertilizer application

The experimental plots were fertilized with recommended dose of 20 kg N and 40 kg P_2O_5 per hectare manually as basal before sowing.

3.6.2 Sowing and post sowing operations

3.6.2.1 Sowing

Seeds of black gram T-9 were used for sowing. Before sowing, seeds were treated with Rhizobium culture and dried under shade. Sowing was done under dry conditions on 13th June 2001 with recommended seed rate of 12 kg ha^{-1}. The seeds were sown manually at a depth of 2-3 cm in the same furrow spaced at 45 cm where fertilizer was band placed previously.

3.6.2.2 Irrigation

No irrigation was applied

3.6.2.3 Application of herbicide

Required quantity of different herbicides were calculated and mixed with water @ 600 litres per hectare as per treatment and spread on soil. Both herbicides (Pendimethalin and oxyfluorfen) were applied on soil as pre-emergence on next day of sowing as per treatments.

3.6.2.4 Gap filling and thinning

After 10 days of sowing gap filling and thinning were carried out to maintain intra row spacing of 10 cm and optimum plant stand.

3.6.2.5 Weeding and interculturing

Weeding and interculturing were done as per treatment.

3.6.2.6 Plant protection measures

The crop was infested by pests like Heliothis (Heliothis armigera) and pod borer during the pod development stage for which recommended plant protection measures were taken.

3.6.2.7 Harvesting and threshing

Previously five tagged plants from each net plot were harvested first and their produce was recorded separately and then after added to respective net plot yield. The ring area was harvested first to eliminate the border effects, then the net plots (remaining six lines after removing border lines) were harvested separately and the produce was kept as such in respective plots to sun drying until constant weight was obtained.

Threshing was done manually by beating the plants with the help of stick. Thereafter seeds were cleaned manually and weight was recorded as per treatments.

3.7 Biometric observations

All the biometric observations studied during the course of investigation are shown in Table-5. Five plants selected from each net plot were tagged for recording observations. The pre and post harvest observations are taken on these five plants and the mean of these five observations was taken for calculations.

3.7.1 Pre-harvest studies

3.7.1.1. Initial and final plant population

Initial and final plant populations were recorded at 15 days after sowing and before harvesting of the crop, respectively from each net plot separately.

3.7.1.2 Plant height

The plant height was measured in centimeters from ground level to the top of the main shoot of the selected five tagged plants from each plot of all the three replications at 20, 40 and 60 days after sowing and at harvest.

3.7.1.3 Number of branches per plant

Number of branches per plant were counted from five selected plants at harvest. Average values of each plot were worked out and recorded.

Table 5 : Morphological and yield parameters recorded during the period of investigation

Characters	Sample size	Time of recording observation
Initial plant population	Net plot	20 DAS
Final plant population	Net plot	At harvest
Plant height	5 plants per net plot	20, 40 and 60 DAS and at harvest
Number of nodules per plant	5 plants per net plot	20, 40 and 60 DAS
Dry matter production per plant	5 plants from ring area	20, 40 and 60 DAS and at harvest
Weed population	1 m2 area in net plot	20, 40 and 60 DAS and at harvest
Dry weight of weeds	1 m2 area in net plot and net plot	At harvest
Days to 50 per cent flowering	Net plot	-
Number of branches per plant	5 plants per net plot	At harvest
Number of pods per plant	5 plants per net plot	At harvest
Number of seeds per pod	10 pods per net plot	At harvest
Test weight (1000-seed weight)	Random sample from each net plot produce	At harvest
Seed yield	Net plot	At harvest
Haulm yield	Net plot	At harvest
Nutrient uptake (for seed, haulm and weed)	Random sample from each net plot produce	After threshing for seeds and at harvest for haulm and weeds
Protein content (from seeds) and protein yield	Random sample from each net plot produce	After threshing

3.7.1.4 Number of nodules per plant

Five plants were dug out randomly from gross plot. The plants were dug out in such a way that no nodules attached to the roots were remained in the soil. These dug out plants were kept as such in a bowl, full of water for easy washing. Then they were washed with clean water. The observations regarding number of nodules per plant were recorded in each treatment for all the replications at 20, 40 and 60 DAS.

3.7.1.5 Dry matter production per plant

Five plant randomly selected from each treatment were harvested from ground level and dried separately in shade for 24 hrs. and subsequently in hot air oven at 70°C for 72 hrs., there after final weight was recorded individually as per treatments at 20, 40 and 60 days after sowing and at harvest.

3.7.1.6 Days to 50 per cent flowering

The number of days from date of sowing to 50 per cent flowering was recorded for each treatment.

3.7.2 Post-harvest studies

3.7.2.1 Number of pods per plant

The filled pods from previously tagged five plants were counted and recorded for each treatment.

3.7.2.2 Number of grains per pod

Randomly selected ten pods were used for counting the number of grains per pod for each treatment.

3.7.2.3 Test weight (1000-grain weight) (g)

Grain samples drawn randomly from the bulk produce of each net plot were used for seed index. One thousand grains counted from the sample and their weight in gram was recorded as test weight for each treatment.

3.7.2.4 Grain yield (kg ha^{-1})

The produce of each net plot was threshed separately, cleaned and the grain yield was recorded in kilograms per net plot.

3.7.2.5 Dry fodder yield (kg ha^{-1})

The plot wise dry fodder yield was counted by deducting the grain yield from the total produce and recorded in kilograms per net plot.

3.7.3 Weed studies

An iron quadrat of 1.0 m x 1.0 m size was randomly placed according to the treatment in each net plot area after ten days of sowing and the site was demarcated for recording observations on weeds during the period of investigation.

3.7.3.1 Weed population

The weed population of monocot, dicot and sedge were counted from the demarcated area of each net plot at 20, 40 and 60 days after sowing and at harvest and recorded accordingly.

3.7.3.2 Dry weight of weeds

The weed samples were collected (At harvest of crop) from the entire net plot area of each treatment. These samples were sun dried first and then finally dried in electrical air oven at 60°C for 24 hrs till constant weight was obtained.

3.7.3.3 Weed Control Efficiency (%)

Weed control efficiency (W.C.E.) was worked out by using the formula suggested by Kondap and Upadhyay (1985).

$$\text{W.C.E. (\%)} = \frac{X-Y}{X} \times 100$$

Where,

X = Dry matter production of weeds in unweeded control

Y = Dry matter production of weeds in treated plot for which WCE is to be worked out

3.8 Bio-chemical studies

Bio-chemical studies pertaining to protein content of seed and nutrient uptake by seed, haulm and weeds were determined as per methods described as under.

3.8.1 Protein content (%) and protein yield (kg ha^{-1})

Representative samples of seed were taken from each treatment and dried in oven at 60°C temperature for 24 hrs. and powdered by mechanical grinder. The nitrogen content of seed was determined by multiplying nitrogen percentage with 6.25.

$$\text{Protein yield (kg ha}^{-1}\text{)} = \frac{\text{Protein content in grain (\%) x Grain yield (kg ha}^{-1}\text{)}}{100}$$

3.8.2 Nutrient content (crop and weed)

N and P_2O_5 content in seed and straw of blackgram crop as well as in weeds were determined by using the following methods.

Sr. No.	Particular	Method
1.	Nitrogen	Modified kjeldahls methods (Jackson, 1967)
2.	Phosphorus	Vanadomolybdophosphoric acid yellow colour method (Jackson, 1967)

3.8.3 Nutrient uptake (crop and weed)

The uptake values of N and P_2O_5 for seed and straw as well as weeds were calculated by using the following formula.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%) x Dry weight (kg ha}^{-1}\text{)}}{100}$$

3.9 Statistical analysis

The statistical analysis of the data of various characters studied in the investigation was carried out by using statistical procedure appropriate to the factorial randomized block design as described by Panse and Sukhatme (1967) and the differences were tested by 'F' test.

Summary tables for treatment effects have been prepared and finished with standard error of mean (S.Em.) and critical difference (C.D.) at 5 per cent level of probability was calculated where the treatment effects were found significant.

3.10 Transformation of data

As the data on weed population showed wide variation, they were subjected to square root transformation ($\sqrt{x+1}$) and then statistically analysed by the standard method as described by Steel and Torrie (1960). Data on nutrient uptake by weeds were analysed as per procedure adopted for crop studies.

3.11 Economics

The gross realization in terms of rupees per hectare was worked out by taking into consideration the seed and stalk yield from each treatment and their prevailing market prices. Likewise, the expenses incurred for all the cultivation operations from preparatory tillage to harvesting including cleaning and threshing as well as the cost of inputs, viz., seeds, fertilizer, weed management treatments and pesticides for each treatment were calculated and deducted from the gross realization to obtain the net realization for each treatment.

EXPERIMENTAL RESULTS

IV EXPERIMENTAL RESULTS

The chapter embodies the results of the present investigation entitled, "Response of Blackgram (*Phaseolus mungo* L. Hepper) to land configuration and weed management practices under South Gujarat conditions", conducted during *kharif* season of the year 2001 at the College Farm, Gujarat Agricultural University, Navsari. The data pertaining to various growth and yield characters, seed and straw yield, weed growth and population, nutrient uptake and economics have been set out in tables and also illustrated graphically wherever necessary in this chapter alongwith statistical inferences.

4.1 Plant population

The data on initial plant population recorded at 15 DAS and final plant population at the time of harvest as influenced by various land configuration and weed management treatments are presented in Table 6.

It is evident from Table 6 that initial plant population as well as final plant stand were not influenced significantly by various treatments.

4.2 Biometric observation

4.2.1 Plant height

Plant height as influenced due to various treatments at 20, 40 and 60 DAS and at harvest are presented in Table 7 and graphically depicted in Fig. 3.

Table 6 : Initial and final plants population of blackgram as influenced by various treatments

Treatment	Plant population (net plot)	
	Initial	Final
Land Configuration (L)		
L_1 = Flat bed method	176.93	176.07
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	177.27	176.20
L_3 = Ridges and furrows	177.60	176.47
S. Em. ±	0.585	0.556
C. D. (0.05)	NS	NS
Weed Management (W)		
W_1 = Unweeded control	176.22	175.00
W_2 = Weed free upto harvest	178.22	177.55
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	177.66	176.55
W_4 = Pendimethalin @ 1.00 kg a.i. ha^{-1}	177.11	176.00
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	177.11	176.11
S. Em. ±	0.756	0.718
C. D. (0.05)	NS	NS
Interaction		
L xW	NS	NS
C. V. %	1.28	1.22

H.W. = Hand weeding I.C. = Interculturing DAS = Days after sowing

Table 7 : Plant height (cm) of blackgram as influenced by various treatments at different growth stages

Treatment	Plant height			
	20 DAS	40 DAS	60 DAS	At harvest
Land Configuration (L)				
L_1 = Flat bed method	11.75	22.51	28.81	31.82
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	12.43	23.75	29.52	32.93
L_3 = Ridges and furrows	12.63	23.82	30.83	33.74
S. Em. $\pm$	0.258	0.388	0.523	0.458
C. D. (0.05)	NS	1.12	1.52	1.33
Weed management (W)				
W_1 = Unweeded control	11.59	22.92	28.20	31.25
W_2 = Weed free upto harvest	12.99	24.75	30.99	34.02
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	12.61	23.43	30.36	33.48
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	12.19	23.20	30.07	33.13
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	11.97	22.51	28.99	32.25
S. Em. $\pm$	0.333	0.501	0.675	0.592
C. D. (0.05)	NS	1.45	1.95	1.72
Interaction				
L x W	NS	NS	NS	NS
C.V %	8.15	6.43	6.82	5.41

H.W. = Hand weeding I.C. = Interculturing DAS = Days after sowing

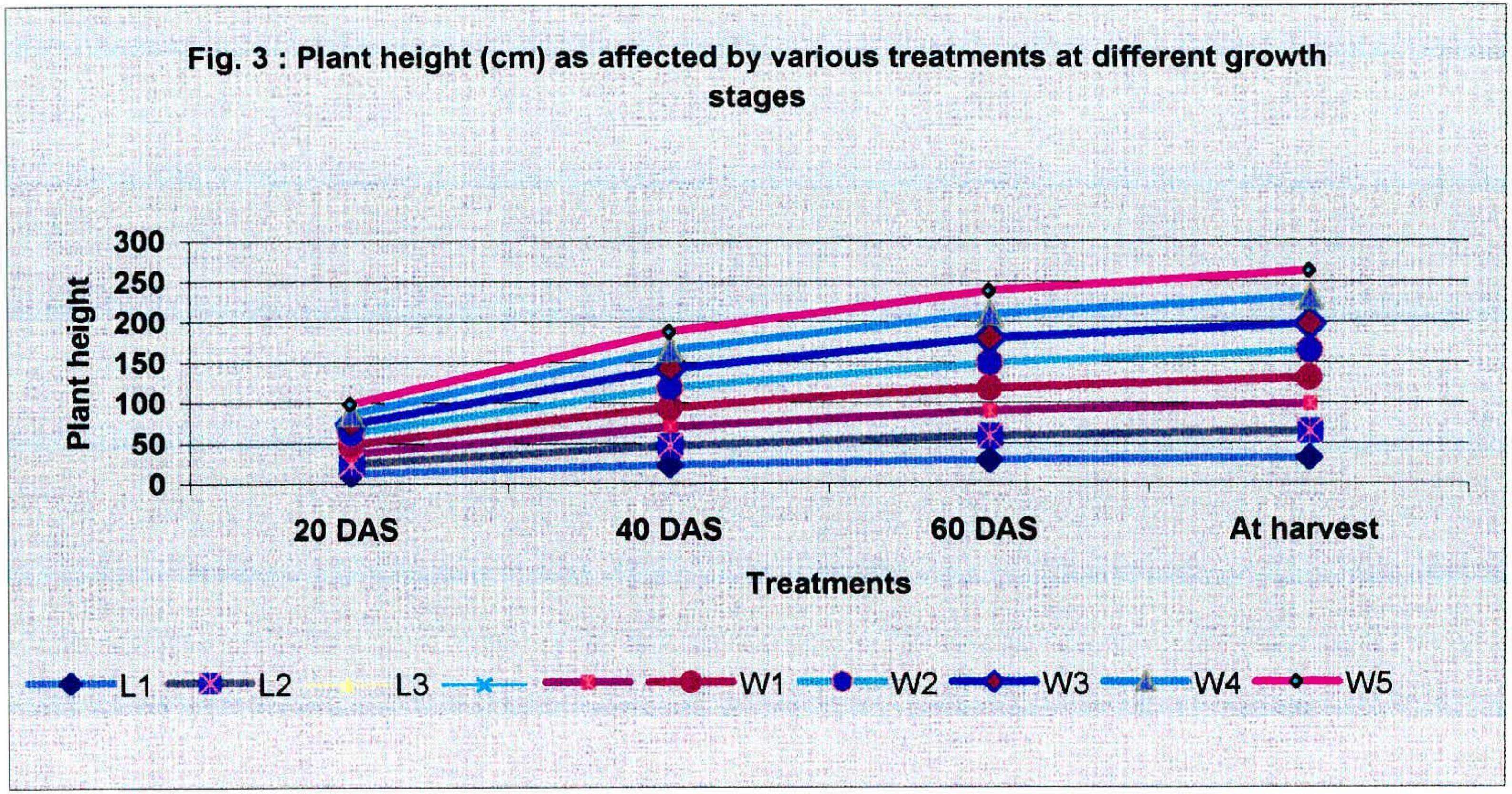


Fig. 3 : Plant height (cm) as affected by various treatments at different growth stages
300
250
200
150
100
50
0
Plant height
20 DAS
40 DAS
60 DAS
At harvest
Treatments
L1
L2
L3
W1
W2
W3
W4
W5

A perusal of data (Table 7) revealed that the plant height was increased continuously upto harvest.

4.2.1.1 Effect of land configuration

Plant height was significantly influenced due to land configuration treatments except at 20 DAS. At 40 and 60 DAS and at harvest, land configuration treatments L_3 and L_2 being at par with each other recorded the highest plant height, which was significantly superior to treatment L_1.

4.2.1.2 Effect of weed management

Plant height also significantly influenced by weed management practices at 40, 60 and at harvest only.

The highest plant height was recorded under treatment W_2 (weed free upto harvest) being at par with W_3 followed by W_4 and W_5. Significantly the lowest plant height was recorded with unweeded control (W_1).

4.2.1.3 Effect of interaction

Interaction effects of both the factors were not significant at 20, 40, 60 DAS and at harvest.

4.2.2 Days to 50 per cent flowering

The mean data on days to 50 per cent flowering in blackgram as influenced by land configuration and weed management treatments are presented in Table 8.

Table 8 : Days to 50 per cent flowering and number of branches per plant at harvest of blackgram as influenced by various treatments

Treatment	Days to 50% flowering	No. of branches $plant^{-1}$
Land Configuration (L)		
L_1 = Flat bed method	42.93	2.45
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	43.07	2.68
L_3 = Ridges and furrows	43.93	2.79
S. Em. $\pm$	0.698	0.089
C. D. (0.05)	NS	0.259
Weed Management (W)		
W_1 = Unweeded control	42.67	2.33
W_2 = Weed free upto harvest	44.00	2.93
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	43.67	2.77
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	43.44	2.60
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	42.78	2.54
S. Em. $\pm$	0.901	0.116
C. D. (0.05)	NS	0.335
Interaction		
L x W	NS	NS
C.V %	6.24	13.17

H.W. = Hand weeding I.C. = Interculturing DAS = Days after sowing

4.2.2.1 Effect of land configuration

The data presented in Table 8 indicated that days to 50 per cent flowering in blackgram remained unaffected due to land configuration.

4.2.2.2 Effect of weed management

The data also revealed that weed management treatments did not exert any significant effect on days to 50 per cent flowering in blackgram.

4.2.2.3 Interaction effect

The interaction between land configuration and weed management treatments were non-significant.

4.2.3 Number of branches/plant

Data on mean number of branches per plant are presented in Table 8.

4.2.3.1 Effect of land configuration

Maximum number of branches per plant were recorded under treatment L_3 (ridges and furrows) being at par with L_2 (raised bed) and both were significantly superior to L_1 (flat bed).

4.2.3.2 Effect of weed management

The mean data (Table-8) revealed that number of branches per plant at harvest were significantly influenced by various weed management treatments. The highest number of branches per plant were noted under weed free treatment (W_2), however, it was at par with W_3 and W_4 treatments. The lowest number of branches per plant were recorded in unweeded control (W_1).

4.2.3.3 Effect of interaction

Interaction effects of both the factors were not significant.

4.2.4 Dry matter production (g/plant)

The data on dry matter production per plant presented in Table-9 and graphically depicted in Fig-4 indicated that the dry matter production per plant increased progressively.

4.2.4.1 Effect of land configuration

The dry matter production per plant was significantly influenced due to land configuration treatments. At 20 DAS, the differences in the dry matter production were not significant but at 40, 60 DAS and at harvest land configuration treatment L_3 (ridge and furrow) recorded maximum dry matter production but it was remained at par with L_2 (raised bed). Both these treatments were significantly superior to treatment L_1 (flat bed).

4.2.4.2 Effect of weed management

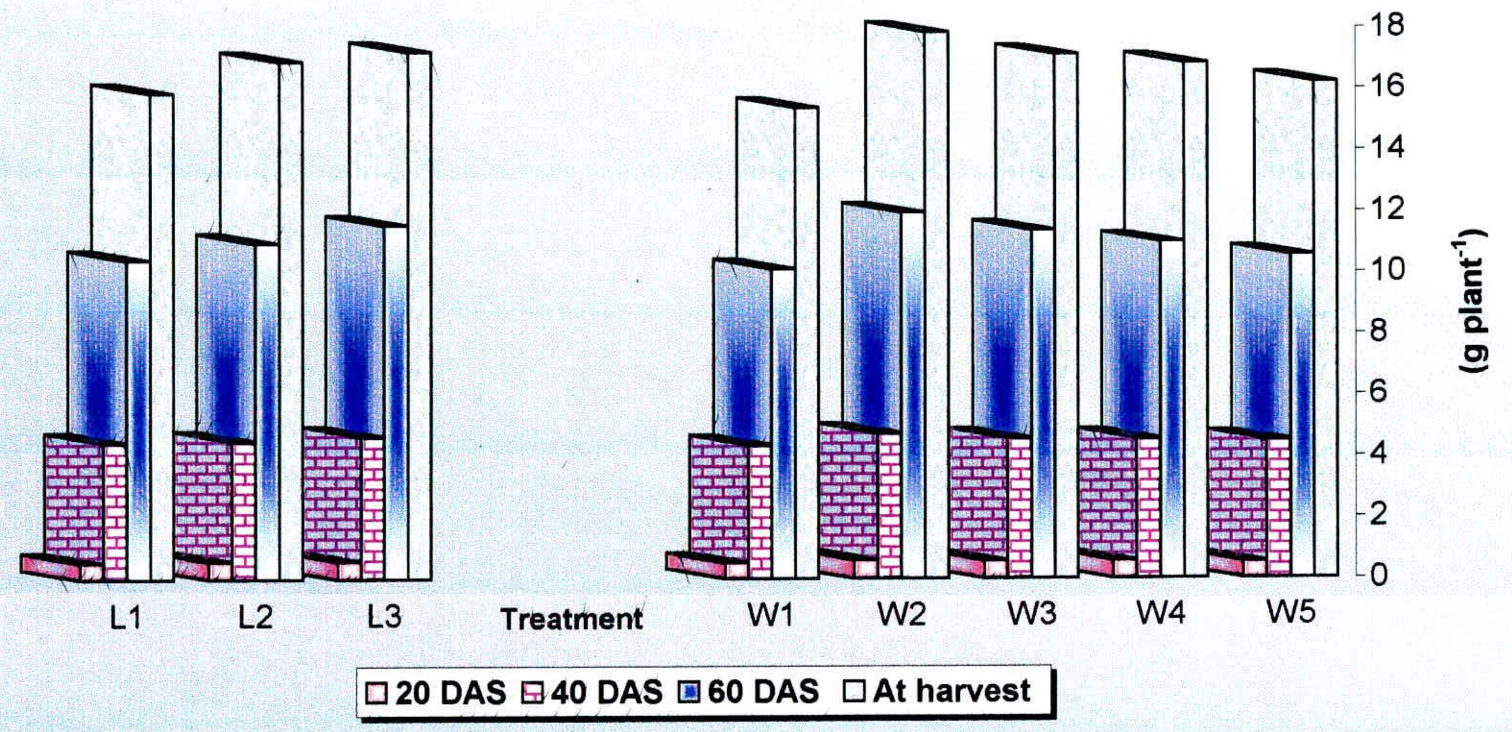
The data presented in Table-9 revealed that dry matter production per plant was significantly influenced by weed management practices. Initially at 20 DAS, the differences in the dry matter were non

Table 9 : Dry matter production per plant (g plant^{-1}) of blackgram as influenced by various treatments

Treatment	Dry matter production (g plant^{-1})			
	20 DAS	40 DAS	60 DAS	At harvest
Land Configuration (L)				
L_1 = Flat bed method	0.54	4.48	10.45	15.91
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	0.58	4.52	10.99	16.93
L_3 = Ridges and furrows	0.59	4.67	11.58	17.25
S. Em. ±	0.019	0.067	0.354	0.475
C. D. (0.05)	NS	0.195	1.026	1.376
Weed management (W)				
W_1 = Unweeded control	0.53	4.37	10.13	15.40
W_2 = Weed free upto harvest	0.60	4.75	11.96	17.87
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	0.59	4.59	11.38	17.13
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	0.58	4.56	11.00	16.84
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	0.55	4.51	10.56	16.22
S. Em. ±	0.015	0.052	0.274	0.368
C. D. (0.05)	NS	0.151	0.079	1.066
Interaction				
L x W	NS	NS	NS	NS
C.V %	9.90	4.44	9.51	8.54

H.W. = Hand weeding I.C. = Interculturing DAS = Days after sowing

Fig. 4 : Dry matter production per plant (g plant^{-1}) of blackgram as influenced by various treatments



significant where as at 40 and 60 DAS and at harvest the differences in dry matter were significant. The highest dry matter production per plant was recorded in the treatment W_2 (Weed free upto harvest) being at par with W_3 and W_4. Significantly the lowest dry matter production was recorded with unweeded control (W_1).

4.2.4.3 Effect of interaction

Interaction effects were found to be non-significant.

4.2.5 Number of root nodules per plant

The mean data on number of root nodules per plant recorded at 20, 40 and 60 DAS are presented in Table 10 and graphically depicted in Fig 5.

4.2.5.1 Effect of land configuration

Land configuration had significant effect on number of root nodules per plant. Ridges and furrows (L_3) recorded significantly the highest number of nodules over flat bed (L_1) however it remained at par with raised bed (L_2) at all the stages.

4.2.5.2 Effect of weed management

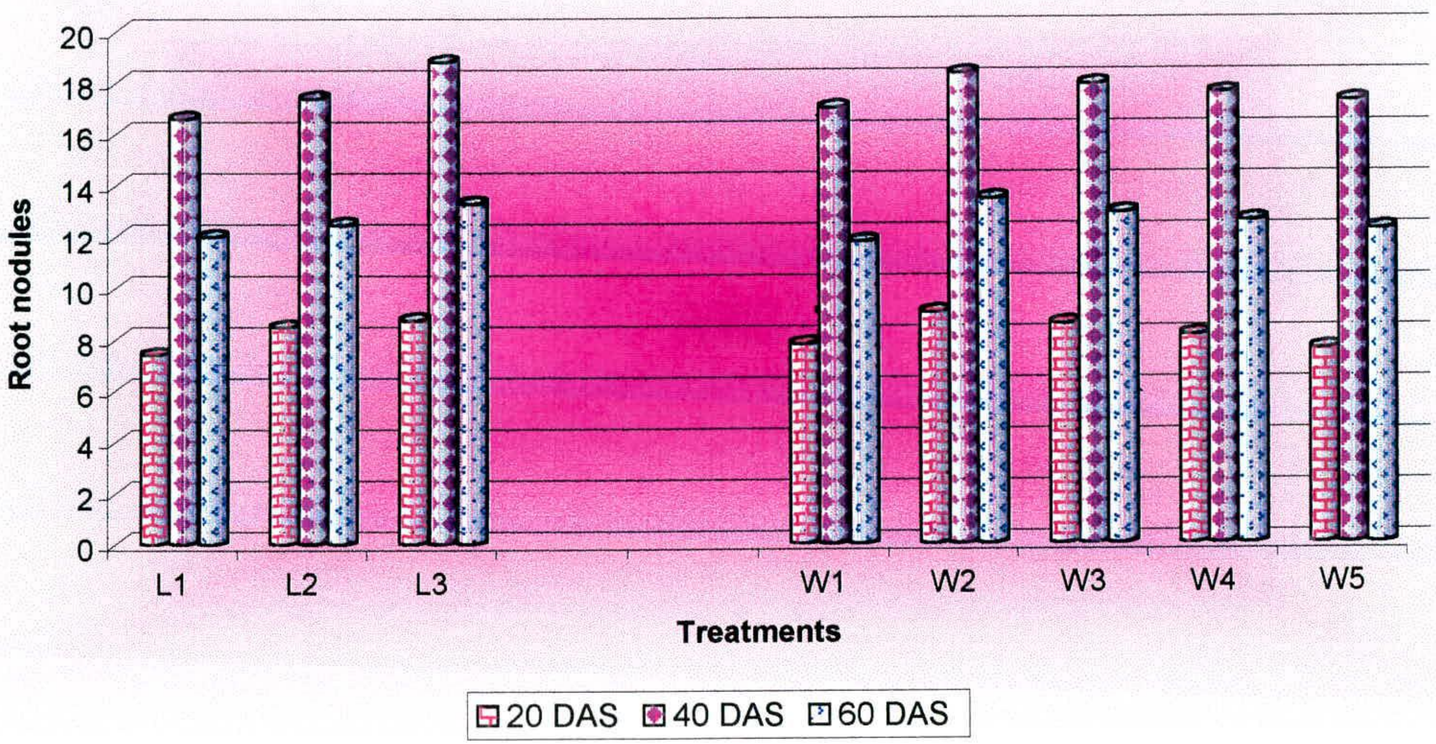
Though the root nodules per plant remained unaffected due to different weed management practices, numerically the higher number of nodules were recorded under treatment W_2 i.e. weed free upto harvest in all the growth stages (Table-10).

Table 10 : Number of root nodules per plant of blackgram as influenced by various treatments

Treatment	No. of root nodules $plant^{-1}$		
	20 DAS	**40 DAS**	**60 DAS**
Land Configuration (L)			
L_1 = Flat bed method	7.40	16.60	12.00
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	8.47	17.40	12.47
L_3 = Ridges and furrows	8.73	18.80	13.27
S. Em. ±	0.310	0.566	0.343
C. D. (0.05)	0.898	1.64	0.992
Weed Management (W)			
W_1 = Unweeded control	7.78	17.00	11.78
W_2 = Weed free upto harvest	9.00	18.33	13.44
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	8.56	17.89	12.89
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	8.11	17.56	12.56
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	7.56	17.22	12.22
S. Em. ±	0.400	0.730	0.442
C. D. (0.05)	NS	NS	NS
Interaction			
L x W	NS	NS	NS
C. V. %	14.65	12.45	10.55

H.W. = Hand weeding I.C. = Interculturing DAS = Days after sowing

Fig. 5 : Number of root nodules per plant of blackgram as influenced by various treatments



4.2.5.3 Interaction effect

None of the interactions was found significant.

4.3. Yield and yield attributes

4.3.1 Number of pods per plant

The mean data on number of pods per plant as influenced by land configuration and weed management treatments are furnished in Table-11 and graphically illustrated in Fig 6.

4.3.1.1 Effect of land configuration

A perusal of data in Table-11 revealed that the number of pods per plant in blackgram were increased significantly by land configuration. The highest number of pods per plant were recorded with L_3 (Ridges and furrows) and remained at par with L_2 (Raised bed). The lowest number of pods per plant were recorded in L_1 (Flat bed).

4.3.1.2 Effect of weed management

The data indicated that various weed management treatments significantly influenced the number of pods per plant. Treatment W_2 i.e. weeds free up to harvest recorded maximum number of pods per plant, but remained statistically at par with W_3 and W_4. The lowest number of pods per plant were recorded under W_1 i.e. unweeded control.

4.3.1.3. Interaction effect

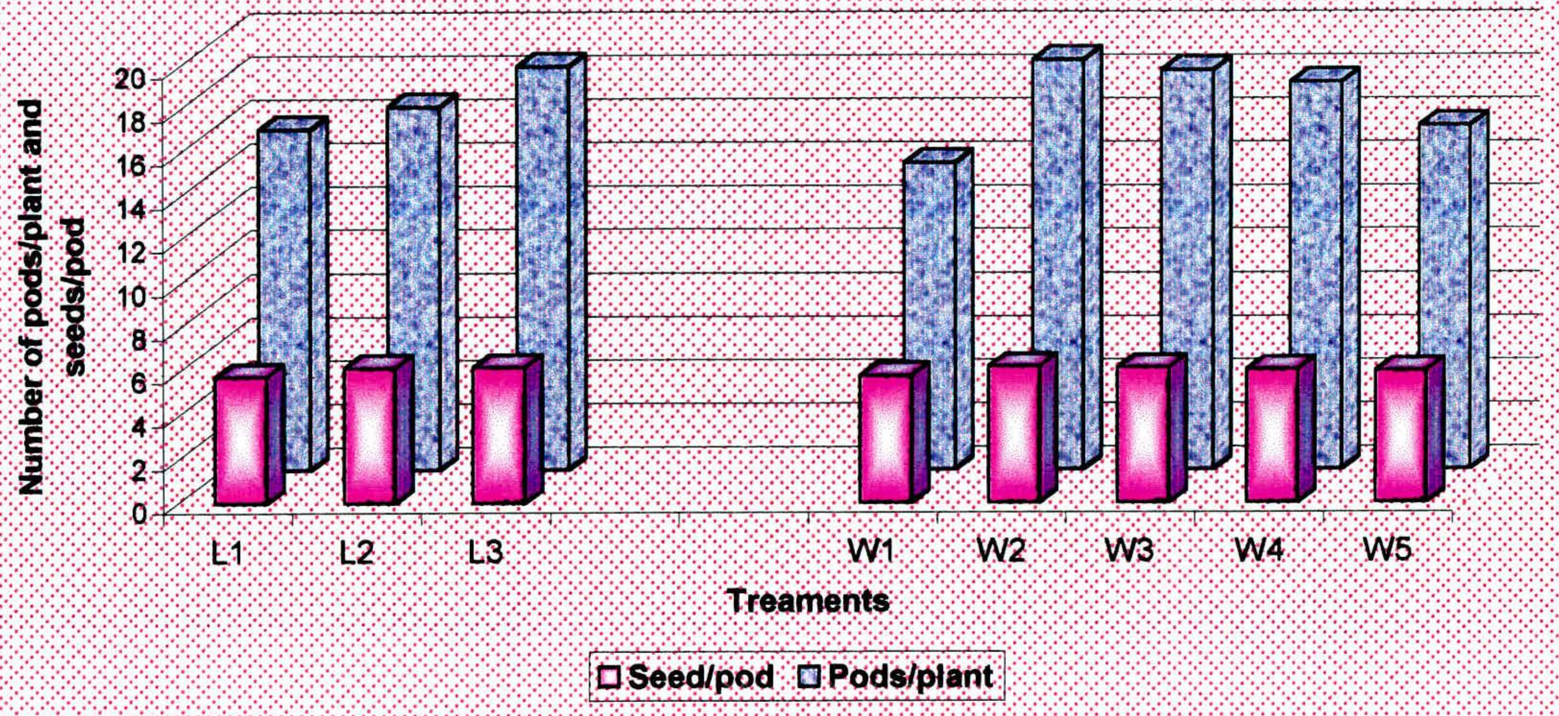
Interaction effect between land configuration and weed management treatments was found to be non-significant.

Table 11: Number of pods per plant, number of seeds per pod and test weight (1000-seed weight in g) of blackgram as influenced by various treatments

Treatment	No. of pods $Plant^{-1}$	No. of seeds Pod^{-1}	Test weight (g)
Land Configuration (L)			
L_1 = Flat bed method	15.65	5.80	45.83
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	16.68	6.20	47.04
L_3 = Ridges and furrows	18.53	6.21	48.50
S. Em. ±	0.772	0.129	0.644
C. D. (0.05)	2.24	NS	1.86
Weed Management (W)			
W_1 = Unweeded control	14.09	5.81	45.66
W_2 = Weed free upto harvest	18.83	6.24	48.80
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	18.36	6.18	48.14
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	17.79	6.09	47.19
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	15.71	6.03	45.81
S. Em. ±	0.997	0.167	0.831
C. D. (0.05)	2.89	NS	2.41
Interaction			
L x W	NS	NS	NS
C. V. %	17.64	8.24	5.29

H.W. = Hand weeding I.C. = Interculturing DAS = Days after sowing

Fig. 6 : Number of pods per plant and number of seeds per pod of blackgram as influenced by various treatments



4.3.2 Number of seeds per pod

The mean data on number of seeds per pod as influenced by land configuration and weed management treatments are presented in Table-11 and graphically illustrated in Fig-6.

4.3.2.1 Effect of land configuration

The data presented in Table-11 indicated that the differences in number of seeds per pod in blackgram were found to be non-significant due to land configuration, however numerically the higher number of seeds per pod were recorded under L_3 (Ridges and furrows) at harvest.

4.3.2.2 Effect of weed management

The data also revealed that weed management treatments did not exert any significant effect on number of seeds per pod in blackgram.

4.3.2.3 Interaction effect

None of the interaction effects was found significant.

4.3.3 Test weight (1000-seed weight in g)

The mean data pertaining to test weight as influenced by land configuration and weed management treatments are given in Table-11.

4.3.3.1 Effect of land configuration

The data indicated that land configurations significantly influenced the test weight in blackgram. Ridges and furrows (L_3)

recorded significantly higher test weight however it remained at per with raised bed (L_2). Significantly the lowest test weight was observed under flat bed (L_1).

4.3.3.2 Effect of weed management

The data (Table-11) indicated significant effect of weed management practices on test weight. The highest test weight was recorded by weed free upto harvest (W_2), but it was found at par with two hand weedings + interculturing with hoe at 20 and 40 DAS (W_3) and also practices (W_3) remained at par with W_4 and W_5. Significantly the lowest test weight was observed under unweeded control (W_1).

4.3.3.3 Interaction effect

Interactions of land configuration and weed management had no significant effect on 1000-grain weight.

4.3.4 Seed yield (kg ha^{-1})

The mean data on seed yield of blackgram as influenced by land configuration and weed management treatments are given in Table-12 and graphically illustrated in Fig 7.

4.3.4.1 Effect of land configuration

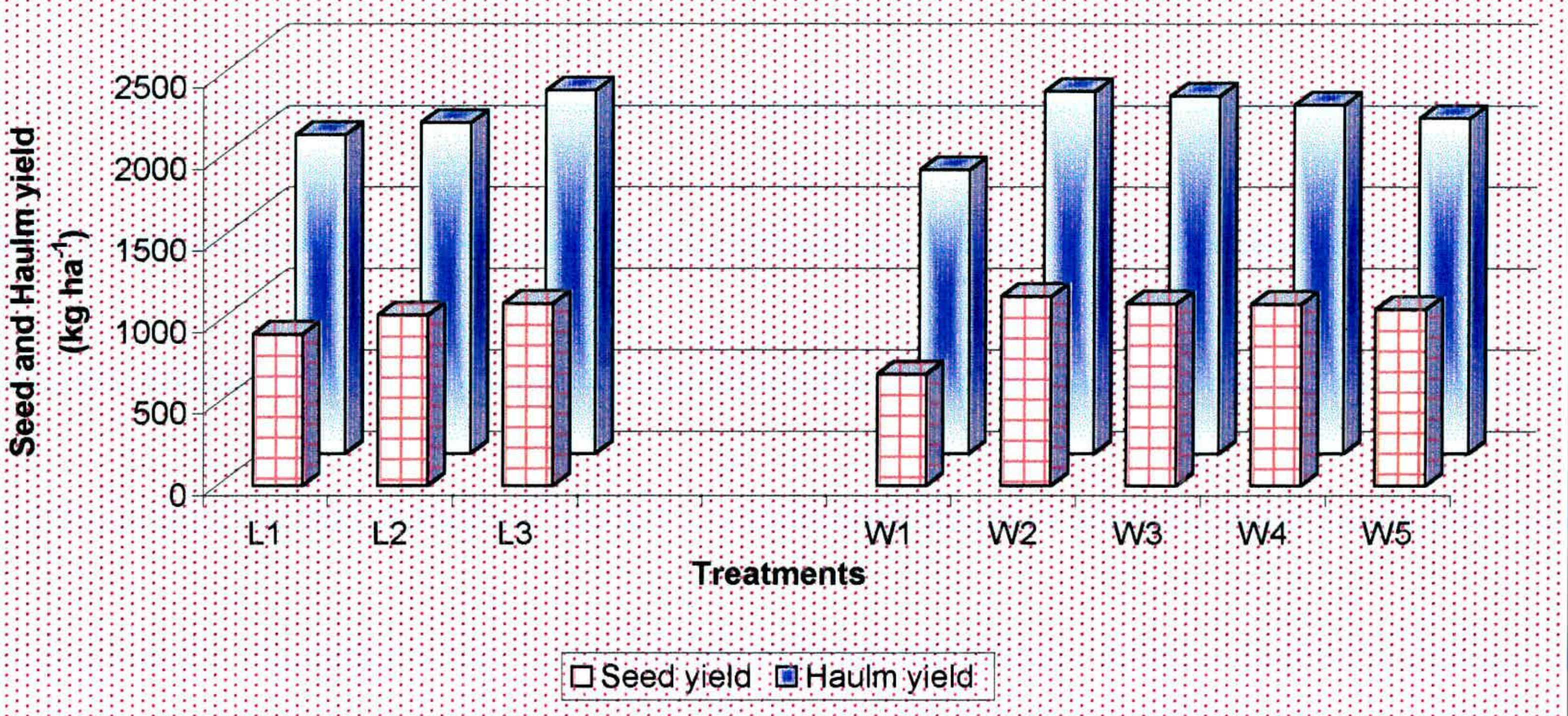
The data in Table-12 showed that seed yield in blackgram affected significantly due to different land configuration methods. The highest seed yield of 1116.33 kg ha^{-1} was obtained under ridges and furrows method (L_3) followed by raised bed (L_2) which yielded 1046.45

Table 12 : Seed and haulm yield (kg ha^{-1}) of blackgram as influenced by various treatments

Treatment	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
Land Configuration (L)		
L_1 = Flat bed method	929.46	1954.00
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	1046.45	2028.80
L_3 = Ridges and furrows	1116.33	2231.87
S. Em. ±	44.17	98.48
C. D. (0.05)	127.93	285.53
Weed Management (W)		
W_1 = Unweeded control	683.54	1739.56
W_2 = Weed free upto harvest	1158.37	2223.56
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	1117.00	2195.45
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	1112.50	2139.89
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	1082.31	2059.33
S. Em. ±	34.22	76.28
C. D. (0.05)	99.09	220.94
Interaction		
L x W	NS	NS
C.V %	12.85	14.26

H.W. = Hand weeding   I.C. = Interculturing   DAS = Days after sowing

Fig. 7: Seed and haulm yield (kg ha^{-1})) of blackgram as influenced by various treatments



kg ha^{-1} seed yield. The method L_1 being at par with L_2 yielded the lowest seed yield (929.46 kg ha^{-1}). The response was observed in the order of $L_3 > L_2 > L_1$.

4.3.4.2 Effect of weed management

The data presented in Table-12 revealed that weed management treatments differed significantly in seed yield. The treatment W_2 (Weed free upto harvest) gave the highest seed yield of 1158.37 kg ha^{-1} being at par with treatment W_3 (Two hand weedings + interculturing with hand hoe at 20 and 40 DAS) and followed by treatment W_4 (Pendimethalin @ 1.0 kg a.i. ha^{-1}). Significantly the lowest seed yield was obtained in W_1 (unweeded control).

4.3.4.3 Effect of interaction

Interaction effects were found to be non-significant.

4.3.5 Haulm yield

The data pertaining to haulm yield of blackgram as influenced by land configuration and weed management treatments are presented in Table-12 and graphically illustrated in Fig 7.

4.3.5.1 Effect of land configuration

An appraisal of data in Table 12 revealed that land configuration methods significantly influenced the haulm yield of blackgram. Significantly higher haulm yield (2231.87 kg ha^{-1}) was obtained under ridges and furrows (L_3) followed by raised bed (L_2). The method flat bed (L_1) remained at par with raised bed (L_2) method with the lowest haulm yield.

4.3.5.2 Effect of weed management

Mean data on haulm yield as influenced by various weed management treatments are tabulated in Table 12. The data clearly indicated that significantly the highest haulm yield (2223.56 kg ha^{-1}) was obtained under weed free upto harvest (W_2) but it was found on par with W_3 and W_4 treatments. The lowest haulm yield (1739.56 kg ha^{-1}) was noted under unweeded control (W_1).

4.4 Weed studies

Data on weed population, weed dry weight, Weed control efficiency and nutrient uptake by weeds are presented here.

Also the predominant weed flora observed in the experimental field are presented in Table-13.

4.4.1 Weed population

Population of monocot, dicot and sedge weeds recorded from one square metre at 20, 40 60 DAS and at harvest are presented in Table 14, 15, 16 and 17 respectively.

4.4.1.1 Weed population at 20 DAS

Weed population as influenced due to various treatments at 20 DAS are presented in Table 14.

Table 13 : Predominant weed flora observed in experimental field

Sr. No.	Family	Botanical name	English name	Local name
[A] Monocot weeds				
1.	Gramineae	*Echinochloa crusgalli* (L.) Beauv	Sama grass	Samo
2.	Gramineae	*Digitaria sanguinalis* (L.) Scop.	Crab grass	Arotaro
3.	Gramineae	*Sorghum halepense* (L.) Pers.	Johnson grass	Baru
4.	Gramineae	*Cynodon dactylon* (L.) Pers.	Barmuda grass	Dharo
5	Gramineae	*Bracharia* spp.	Signal grass	Bharbhi
[B] Dicot weeds				
1.	Amaranthaceae	*Amaranthus viridis* L.	Pig weed	Tandaljo
2.	Amaranthaceae	*Alternanthera sessilis*	-	Khaki weed
3.	Amaranthaceae	*Digera arvensis* Forsk.	Amaranthus	Kanjaro
4.	Convolvulaceae	*Convolvulus arvensis* L.	Field bind weed	Chandan wel
5.	Compositae	*Eclipta alba* (L.) Hassk	False daisy	Bhangra
6.	Compositae	*Vernonia cinerea* Less.	Phulni	Fulakia
7.	Euphorbiaceae.	*Euphorbia hitra* L.	Spurge	Dudheli
8.	Euphorbiaceae	*Euphorbia mudarasptiensis*	Cron spurey	Sikari
9.	Leguminosae	*Cassia tora* L.	Sickle pod	Kuvadia
10.	Solanaceae	*Physalis minima* L.	Ground cherry	Popti
[C] Sedge				
1.	Cyperaceae	*Cyperus rotundus* L.	Nut sedge	Chidho

4.4.1.2 Effect of land configuration

The data presented in Table 14 showed that the population of monocot, dicot and sedge weeds at 20 DAS were remained unaffected due to different land configuration methods, but numerically the lowest number of monocot, dicot and sedge was observed under ridge and furrows (L_3) followed by raised bed (L_2) and the highest number of weeds observed under flat bed (L_1).

4.4.1.3 Effect of weed management

The data presented in Table 14 revealed that effects of weed management practices on density of different weed species were significant at 20 DAS. The mean value of weed population recorded under various weed control treatments clearly showed, the lowest number of monocot weeds were found under treatment W_3 i.e. two hand weedings + interculturing at 20 and 40 DAS at par with treatments W_4 and W_5 where as, the highest number of monocot under unweeded control (W_1).

The lowest number of dicot weeds were observed under treatment W_3 i.e. 2 hand weedings + interculturing at 20 and 40 DAS being at par with treatments W_4 and W_5. Significantly the highest dicot weeds were found under unweeded control (W_1).

The lowest number of sedges were observed under treatments W_3 i.e. 2 hand weedings + interculturing at 20 and 40 DAS but remained at par with treatments W_4 and W_5. The highest weed population was observed under unweeded control (W_1) being at par with W_5.

Table 14 : Weed population at 20 DAS as influenced by various treatments

Treatment	Weed population per Sq.m.		
	Monocot	Dicot	Sedge
Land Configuration (L)			
L_1 = Flat bed method	3.04 (8.24)	5.86 (33.34)	5.90 (33.81)
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	2.95 (7.70)	5.72 (31.72)	5.85 (33.22)
L_3 = Ridges and furrows	2.90 (7.41)	5.49 (29.14)	5.78 (32.41)
S. Em. ±	0.082	0.245	0.168
C. D. (0.05)	NS	NS	NS
Weed Management (W)			
W_1 = Unweeded control	4.43 (18.63)	9.17 (83.08)	8.26 (67.23)
W_2 = Weed free upto harvest	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	2.97 (7.82)	5.08 (24.81)	5.95 (34.40)
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	3.19 (9.17)	6.09 (36.08)	6.98 (47.72)
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	3.21 (9.30)	7.12 (49.69)	7.03 (48.42)
S. Em. ±	0.063	0.190	0.130
C. D. (0.05)	0.183	0.550	0.377
Interaction			
L x W	NS	NS	NS
C. V. %	8.26	12.94	8.63

H.W. = Hand weeding   I.C. = Interculturing   DAS = Days after sowing

Data in parenthesis indicate actual value and those out side are $\sqrt{x+1}$ transformed values

4.4.1.4 Interaction effect

Interaction effect of land configuration methods and weed control methods not reached upto the level of significance with respect to all the categories of weed flora at 20 DAS.

4.4.2 Weed population at 40 DAS

Weed population as influenced due to various treatments at 40 DAS are presented in Table 15.

4.4.2.1 Effect of land configuration

The density of different weed species did not differ significantly by land configuration methods at 40 DAS. The lowest number of monocot, dicot and sedges were observed under ridges and furrows (L_3) followed by raised bed (L_2) and the highest number of weeds were observed under flat bed (L_1).

4.4.2.2 Effect of weed management

Data in Table 15 indicated that monocot, dicot and sedge at 40 DAS were significantly influenced by various weed management treatments.

The lowest number of monocot, dicot and sedge weeds were recorded in treatments W_3 i.e. 2 hand weedings + interculturing at 20 and 40 DAS but it was at par with treatments W_4 and W_5. The highest number of monocot, dicot and sedge weeds were recorded under unweeded control (W_1).

Table 15 : Weed population at 40 DAS as influenced by various treatments

Treatment	Weed population per Sq.m.		
	Monocot	**Dicot**	**Sedge**
Land Configuration (L)			
L_1 = Flat bed method	5.72 (31.72)	6.65 (43.22)	1.89 (2.57)
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	5.58 (30.14)	6.23 (37.81)	1.97 (2.88)
L_3 = Ridges and furrows	5.17 (25.73)	6.05 (35.60)	1.83 (2.35)
S. Em. ±	0.239	0.241	0.111
C. D. (0.05)	NS	NS	NS
Weed Management (W)			
W_1 = Unweeded control	7.90 (61.48)	8.03 (63.48)	2.52 (5.35)
W_2 = Weed free upto harvest	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	5.73 (31.83)	7.09 (49.27)	1.93 (2.73)
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	6.23 (37.81)	7.51 (55.40)	1.98 (2.92)
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	6.58 (42.29)	7.92 (61.73)	2.04 (3.16)
S. Em. ±	0.185	0.187	0.359
C. D. (0.05)	0.537	0.542	0.249
Interaction			
L x W	NS	NS	NS
C. V. %	13.08	11.48	17.55

H.W. = Hand weeding I.C. = Interculturing DAS = Days after sowing

Data in parenthesis indicate actual value and those out side are $\sqrt{x+1}$ transformed values

4.4.2.3 Interaction effect

Interaction effect between land configuration methods and weed management practices remained absent with respect to all the categories of weed population at 40 DAS.

4.4.3 Weed population at 60 DAS

Weed population as influenced due to various treatments at 60 DAS are presented in Table 16.

4.4.3.1 Effect of land configuration

Mean data on weed population (Monocots, Dicots and Sedges) at 60 DAS as influenced by different treatments under studies presented in Table 16 showed that the effect of different land configuration methods on weed population was non-significant at 60 DAS. But numerically lowest weed population was observed under treatment L_3 (Ridge and furrow) followed by L_2 (raised bed). The highest weed population was observed under L_1 (flat bed).

4.4.3.2 Effect of weed management

The population of monocot, dicot and sedge weeds were recorded at 60 DAS as affected significantly by various weed management treatments (Table 16).

Significantly, the lowest monocot, dicot and sedges weeds were recorded under W_3 i.e 2 hand weedings + interculturing at 20 and 40 DAS which was remained at par with treatments W_4 and W_5.

Table 16 : Weed population at 60 DAS as influenced by various treatments

Treatment	Weed population per Sq.m.		
	Monocot	Dicot	Sedge
Land Configuration (L)			
L_1 = Flat bed method	6.27 (38.31)	6.67 (43.49)	2.94 (7.64)
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	5.94 (34.28)	6.40 (39.96)	2.83 (7.01)
L_3 = Ridges and furrows	5.92 (34.05)	6.05 (35.60)	2.62 (5.86)
S. Em. ±	0.218	0.295	0.124
C. D. (0.05)	NS	NS	NS
Weed Management (W)			
W_1 = Unweeded control	8.02 (63.32)	10.03 (99.60)	3.62 (12.10)
W_2 = Weed free upto harvest	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	6.82 (45.51)	6.49 (41.12)	3.04 (8.24)
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	7.18 (50.55)	7.06 (49.84)	3.14 (8.86)
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	7.20 (50.84)	7.30 (52.29)	3.18 (9.11)
S. Em. ±	0.169	0.229	0.095
C. D. (0.05)	0.490	0.694	0.277
Interaction			
L x W	NS	NS	NS
C. V. %	10.84	13.89	13.28

H.W. = Hand weeding   I.C. = Interculturing   DAS = Days after sowing

Data in parenthesis indicate actual value and those out side are $\sqrt{x+1}$ transformed values

Significantly the highest monocot, dicot and sedges weeds were found under unweeded control (W_1).

4.4.3.3 Interaction effect

Interaction effect between land configuration and weed management treatments was found to be non-significant.

4.4.4 Weed population at harvest

The data presented in Table 17 indicated that weed population at harvest was not affected significantly by various treatments.

4.4.4.1 Effect of land configuration

The population of different weed species did not differ significantly by land configuration methods at harvest. However the lowest number of monocot, dicot and sedges were observed under ridges and furrows (L_3) followed by raised bed (L_2) and the highest number of weeds were observed under flat bed (L_1).

4.4.4.2 Effect of weed management

The data presented in Table 17 indicated that weed population at harvest was significantly affected by various weed management treatments.

The lowest monocot weed population was recorded under W_3 i.e. 2 hand weedings + interculturing at 20 and 40 DAS but found at par

Table 17 : Weed population at harvest as influenced by various treatments

Treatment	Weed population per Sq.m.		
	Monocot	Dicot	Sedge
Land Configuration (L)			
L_1 = Flat bed method	7.41 (53.91)	9.24 (84.38)	5.07 (24.71)
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	7.31 (52.44)	8.59 (72.79)	4.60 (20.16)
L_3 = Ridges and furrows	7.14 (49.98)	8.37 (69.06)	4.44 (18.71)
S. Em. $\pm$	0.391	0.399	0.249
C. D. (0.05)	NS	NS	NS
Weed Management (W)			
W_1 = Unweeded control	9.72 (93.48)	13.24 (174.30)	7.07 (48.99)
W_2 = Weed free upto harvest	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	7.99 (62.84)	8.99 (79.82)	4.91 (23.11)
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	8.67 (74.17)	9.68 (92.70)	5.09 (24.91)
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	9.06 (81.08)	10.75 (114.56)	5.46 (28.81)
S. Em. $\pm$	0.303	0.309	0.193
C. D. (0.05)	0.877	0.894	0.558
Interaction			
L x W	NS	NS	NS
C. V. %	16.10	13.69	15.87

H.W. = Hand weeding   I.C. = Interculturing   DAS = Days after sowing

Data in parenthesis indicate actual value and those outside are $\sqrt{x+1}$ transformed values with W_4 and W_5. Significantly higher monocot weeds were found under treatment W_1.

The lowest monocot weed population was recorded under W_3 i.e. two H.W. + interculturing with hoe at 20 and 40 DAS but found at par with W_4 and W_5. Significantly higher monocot weeds were found under treatment W_1.

The lowest number of dicot and sedges were observed under treatments W_3 and W_4 but both the treatments were remained at par with treatments W_5. The highest weed population was observed under unweeded control (W_1).

4.4.4.3 Interaction effect

Interaction effect between land configuration and weed management treatments was found to be non-significant.

4.4.5 Dry weight of weeds

The mean data on dry weight of weeds as influenced by various weed management treatments recorded at harvest are presented in Table 18 and graphically depicted in fig.8.

4.4.5.1 Effect of land configuration

The mean data indicated that effect of varying land configuration methods was non-significant. But numerically lowest dry weight of weeds was observed under ridge and furrow method followed

Table 18 : Dry weight of weeds and weed control efficiency as influenced by various treatments

Treatment	Dry weight of weeds At harvest ($kg\ ha^{-1}$)	WCE (%) At harvest
Land Configuration (L)		
L_1 = Flat bed method	20.15 (405.02)	-
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	19.83 (392.23)	-
L_3 = Ridges and furrows	18.09 (326.25)	-
S. Em. ±	1.154	-
C. D. (0.05)	NS	-
Weed Management (W)		
W_1 = Unweeded control	37.82 (1429.35)	-
W_2 = Weed free upto harvest	1.00 (0.00)	-
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	16.79 (280.90)	80.35
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	19.45 (377.30)	73.60
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	21.73 (471.19)	67.03
S. Em. ±	0.834	-
C. D. (0.05)	2.588	-
Interaction		
L x W	NS	-
C.V %	17.87	-

H.W. = Hand weeding   I.C. = Interculturing   DAS = Days after sowing

Data in parenthesis indicate actual value and those outside are $\sqrt{x+1}$ transformed values

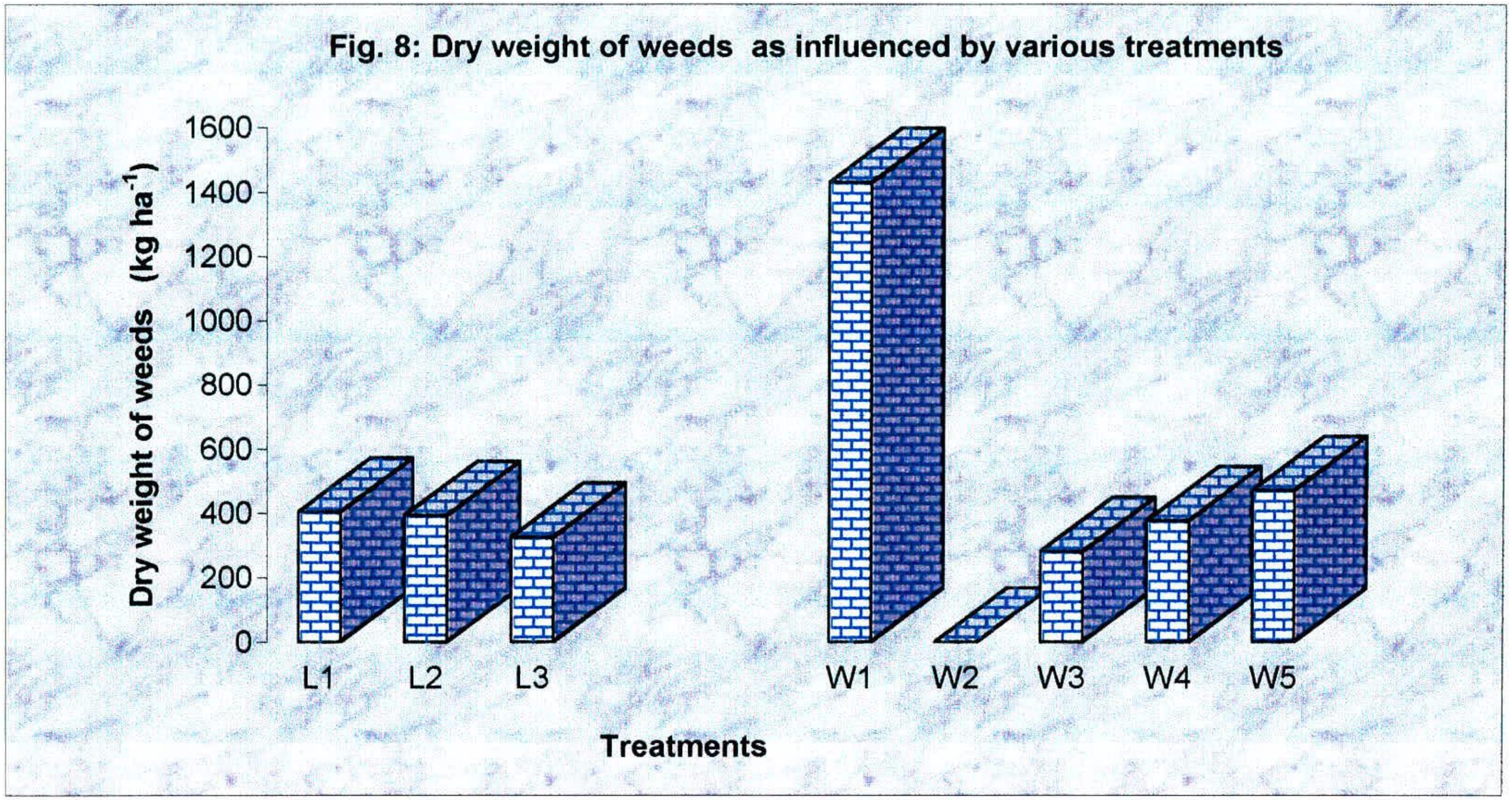


Fig. 8: Dry weight of weeds as influenced by various treatments
Dry weight of weeds (kg ha-1)
1600
1400
1200
1000
800
600
400
200
0
L1
L2
L3
W1
W2
W3
W4
W5
Treatments

by raised bed. The highest dry weight of weeds was observed under flat bed method (L_1).

4.4.5.2 Effect of weed management

Different weed management treatments significantly influenced the dry weight of weeds at harvest. Significantly the highest dry weight of weeds was recorded under unweeded control (W_1). Whereas, the lowest dry weight of weeds was recorded under the treatment W_2 (weed free upto harvest) and was remained at par with treatments W_3, W_4 and W_5.

4.4.5.3 Interaction effect

The interaction of various land configuration methods and weed control methods was non-significant.

4.4.6 Weed control efficiency (%)

The data on weed control efficiency calculated in terms of percentage are presented in Table 18.

A perusal of data in Table 18 revealed that the highest weed control efficiency (80.35 %) was recorded under treatment W_3 (two hand weedings + interculturing with hoe at 20 and 40 DAS) followed by application of pendimethalin @ 1.0 kg a.i. ha^{-1} (73.60 %) and oxyfluorfen @ 0.24 kg a.i. ha^{-1} (67.03%).

4.5 Quality characters

The data on protein content (%) and protein yield ($kg\text{-}ha^{-1}$) as influenced by different treatments are presented in Table 19.

Table 19: Protein content (%) and protein yield (kg ha^{-1}) of blackgram as influenced by various treatments

Treatment	Protein content (%)	Protein yield (kg ha^{-1})
Land Configuration (L)		
L_1 = Flat bed method	19.30	180.23
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	19.63	206.79
L_3 = Ridges and furrows	19.79	222.50
S. Em. ±	0.415	11.45
C. D. (0.05)	NS	33.17
Weed Management (W)		
W_1 = Unweeded control	18.61	127.72
W_2 = Weed free upto harvest	21.04	245.89
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	19.52	217.47
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	19.45	217.10
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	19.24	207.69
S. Em. ±	0.536	8.87
C. D. (0.05)	1.55	25.69
Interaction		
L x W	NS	NS
C.V %	8.22	16.91

H.W. = Hand weeding I.C. = Interculturing DAS = Days after sowing

4.5.1 Protein content (%)

4.5.1.1 Effect of land configuration

The mean data indicated that effect of varying land configuration methods were non-significant. However the highest and the lowest protein content were observed under L_3 (Ridges and furrows) and L_1 (Flat bed), respectively.

4.5.1.2 Effect of weed management

The data showed that the differences in protein content (%) was affected significantly. The highest protein content (21.04%) was recorded under treatment W_2 i.e. weed free upto harvest but was found at par with W_3 unweeded control which registered the lowest protein content of 18.61 per cent.

4.5.1.3 Interaction effect

Interaction effect between land configuration and weed management treatments was found to be non-significant.

4.5.2 Protein yield (kg ha^{-1})

The data on protein yield (kg ha^{-1}) as influenced by various treatments are presented in Table 19.

4.5.2.1 Effect of land configuration

The mean data indicated that effect of varying land configuration methods was significant. The highest (222.50 kg ha^{-1})

protein yield was recorded under ridges and furrows (L_3) being at par with treatments L_2. Whereas, the lowest protein yield of 180.23 kg ha^{-1} was registered under flat bed method (L_1).

4.5.2.2 Effect of weed management

Significantly the highest (245.89 kg ha^{-1}) protein yield was recorded under weed free upto harvest (W_2) followed by treatments W_3, W_4 and W_5. Whereas the lowest protein yield of 127.72 kg ha^{-1} was registered under unweeded control (W_1).

4.5.2.3 Interaction effect

Interaction effects of both the factors was non-significant.

4.6 Nutrient uptake

Results pertaining to uptake of nitrogen and phosphorus by seed and haulm of blackgram as well as weeds as affected by various land configuration and weed management treatments are furnished in Table 20 and 21 respectively.

4.6.1 Nutrient uptake by seed and haulm

The mean data on nutrient (nitrogen and phosphorus) uptake by seed as well as haulm are presented in Table 20.

4.6.1.1 Nitrogen uptake by seed and haulm

4.6.1.2 Effect of land configuration

The mean data indicated that effect of varying land configuration methods was found significant. The highest nitrogen

Table 20 : Nitrogen and phosphorus uptake (kg ha^{-1}) by seed and haulm of blackgram as influenced by various treatments

Treatment	Nutrient uptake (kg ha^{-1})			
	Nitrogen		Phosphorus	
	Seed	Haulm	Seed	Haulm
Land Configuration (L)				
L_1 = Flat bed method	22.83	14.33	3.81	2.06
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	33.24	14.90	4.31	2.21
L_3 = Ridges and furrows	35.60	16.57	4.80	2.48
S. Em. ±	1.85	0.716	0.257	0.178
C. D. (0.05)	5.36	2.07	0.745	0.516
Weed management (W)				
W_1 = Unweeded control	20.40	12.62	2.61	1.77
W_2 = Weed free upto harvest	39.34	16.94	5.07	2.81
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	34.79	16.27	4.74	2.34
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	34.73	15.63	4.68	2.23
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	33.48	14.86	4.43	2.10
S. Em. ±	1.43	0.554	0.199	0.138
C. D. (0.05)	4.15	1.61	0.58	0.399
Interaction				
L x W	NS	NS	NS	NS
C.V %	17.06	14.06	17.93	23.75

H.W. = Hand weeding I.C. = Interculturing DAS = Days after sowing

uptake by seed as well as haulm were recorded with treatment L_3 (ridge and furrow) but remained on same bar with treatment L_2. The lowest nitrogen uptake by seed and haulm was registered under treatment flat bed (L_1).

4.6.1.3 Effect of weed management

A perusal of data in Table 20 indicated that significantly the highest nitrogen uptake by seed as well as haulm was recorded with treatments W_2 (weed free upto harvest). The lowest nitrogen uptake by seed and haulm were registered under treatment unweeded control (W_1).

4.6.1.4 Interaction effect

Interaction effect of both treatments were non-significant.

4.6.2 Phosphorus uptake by seed and haulm

4.6.2.1 Effect of land configuration

The mean data indicated that significantly the highest phosphorus uptake by seed as well as haulm was recorded under ridge and furrow (L_3) but remained at par with raised bed (L_2). The lowest phosphorus uptake by seed and haulm was registered under treatment flat bed (L_1).

4.6.2.2 Effect of weed management

The mean data furnished in Table 20 showed that phosphorus uptake by seed and haulm was significantly higher under treatment W_2

Table 21: Nitrogen and phosphorus uptake (kg ha^{-1}) by weeds as influenced by various treatments

Treatment	Nutrient uptake (kg ha^{-1})	
	Nitrogen	Phosphorus
Land Configuration (L)		
L_1 = Flat bed method	5.10	2.58
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	4.89	2.77
L_3 = Ridges and furrows	4.77	2.54
S. Em. ±	0.318	0.234
C. D. (0.05)	NS	NS
Weed Management (W)		
W_1 = Unweeded control	8.04	7.12
W_2 = Weed free upto harvest	0.00	0.00
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	4.87	1.41
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	5.46	2.13
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	6.24	2.51
S. Em. ±	0.246	0.182
C. D. (0.05)	0.713	0.526
Interaction		
L x W	NS	NS
C.V %	19.37	26.70

H.W. = Hand weeding   I.C. = Interculturing   DAS = Days after sowing

i.e. weed free upto harvest but remained statistically at par with treatment W_3 and W_4 in case of seed only.

4.6.2.3 Interaction effect

Interaction effect was non-significant.

4.7 Nutrient uptake by weeds

The mean data pertaining to nutrient uptake i.e. nitrogen and phosphorus uptake are tabulated in Table 21.

4.7.1 Nitrogen uptake by weeds

4.7.1.1 Effect of land configuration

Data presented in Table 21 indicated that effect of varying land configuration methods were non-significant. There is no remarkable influence on nutrient uptake by weeds due to different land configuration methods. But highest uptake was observed under flat bed (L_1) lowest uptake of nitrogen was observed under (L_3) ridge and furrow method.

4.7.1.2 Effect of weed management

A perusal of data in Table 21 indicated that treatment of two hand weedings + interculturing at 20 and 40 DAS (W_3) recorded significantly the lowest (4.87 kg ha^{-1}) nitrogen uptake by weeds being statistically at par with treatments W_4 and W_5. Whereas, the treatment W_1 i.e. unweeded control showed the highest nitrogen uptake by weeds (8.04 kg $ha\text{-}^{1}$).

4.7.1.3 Interaction effect

Interaction effect of both the factors were non-significant.

4.7.2 Phosphorus uptake by weeds

4.7.2.1 Effect of land configuration

The mean data (Table 21) indicated no remarkable influence of land configuration treatments on phosphorus uptake by weeds.

4.7.2.2 Effect of weed management

The mean data furnished in Table 21 revealed that significantly the highest phosphorus uptake by weeds (7.12 kg ha^{-1}) was recorded under treatment unweeded control (W_1). Significantly the lowest phosphorus uptake was recorded under treatment W_3 (1.41 kg ha^{-1}) but remained on same bar with treatments W_4 and W_5.

4.7.2.3 Interaction effect

Interaction effect between both the factors were non-significant.

4.8 Economics

The economics of various land configuration and weed management treatments imposed in *kharif* blackgram is presented in Appendix-II and prevailing market price of produces and inputs are furnished in Appendix-III.

The economics indicating total income, total cost of cultivation, net profit and cost benefit ratio (CBR) under various land configuration and weed management treatments are presented in Table 22 and illustrated graphically in fig 9.

4.8.1 Economics of different treatments

The details of income and expenditure alongwith net realization under different land configuration methods and weed management treatments are presented in Table 22.

4.8.1.1 Effect of land configuration

Among different land configuration methods, the maximum net realization of Rs. 13104 ha^{-1} was obtained under ridges and furrows method (L_3) followed by raised bed (L_2) Rs. 11755 ha^{-1} and under flat bed (L_1) Rs. 10562 ha^{-1}.

4.8.1.2 Effect of weed management

A perusal of data presented in Table 22 revealed that the highest net profit of Rs. 12296 ha^{-1} was obtained from treatment W_3 (two hand weedings + interculturing with hoe at 20 and 40 DAS) followed by treatments W_2 (Rs. 11731 ha^{-1}) and W_4 (Rs. 11574 ha^{-1}).

4.8.2 Cost benefit ratio (C.B.R.)

The cost benefit ratio for various treatments were computed and presented in Table 22.

Table 22 : Economics of various treatments

Treatment	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Gross realization (Rs ha^{-1})	Mean cost of production (Rs. ha^{-1})	Net realization (Rs. ha^{-1})	Cost : benefit ratio
Land configuration (L)						
L_1 = Flat bed method	929.46	1954.00	14918.9	5902.4	10562.9	1.78
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	1046.45	2028.80	16711.2	6502.4	11755.2	1.81
L_3 = Ridges and furrows	1116.33	2231.87	17860.9	6302.4	13104.9	2.08
Weed management (W)						
W_1 = Unweeded control	683.54	1739.56	11122.9	4689.3	6766.9	1.44
W_2 = Weed free upto harvest	1158.37	2223.56	18487.3	7089.3	11731.3	1.66
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	1117.00	2195.44	17852.7	5889.3	12296.7	2.09
W_4 = Pendimethalin @ 1.00 kg a.i. ha^{-1}	1112.50	2139.89	17757.5	6516.3	11574.5	1.78
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	1082.31	2059.33	17264.4	6994.3	10603.4	1.52

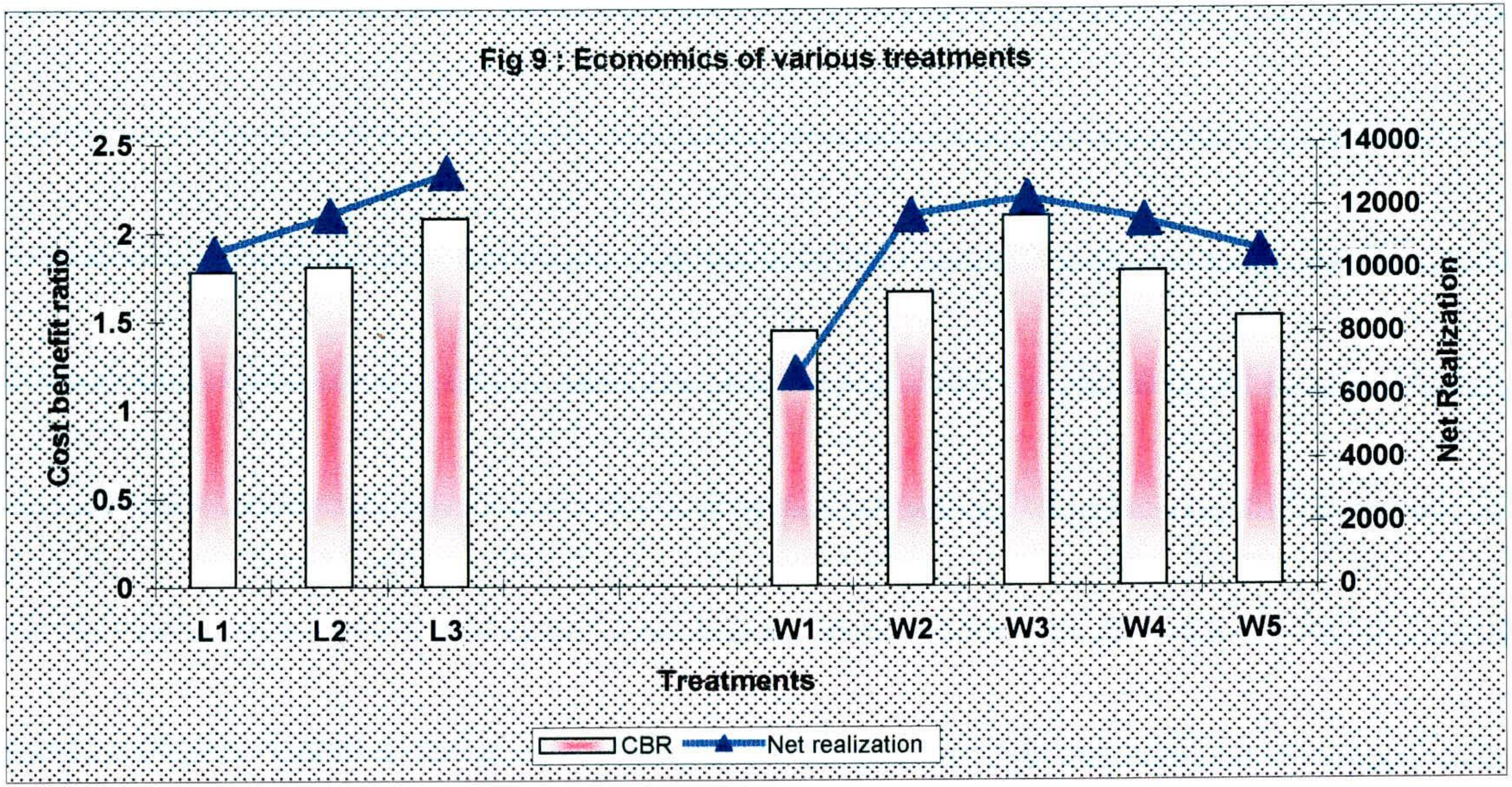


Fig 9 : Economics of various treatments
Cost benefit ratio
2.5
2
1.5
1
0.5
0
14000
12000
10000
8000
6000
4000
2000
0
Net Realization
L1
L2
L3
W1
W2
W3
W4
W5
Treatments
CBR
Net realization

4.8.2.1 Effect of land configurations

Amongst three land configuration methods, ridges and furrows method (L_3) recorded the maximum C.B.R. value of 2.08 per rupee invested, followed by raised bed (L_2) with C.B.R. of 1:1.81 and flat bed (L_1) with C.B.R. of 1:1.78.

4.8.2.2 Effect of weed management

Among weed management treatments, the treatment of two hand weedings + interculturing with hoe at 20 and 40 DAS (W_3) gave the higher CBR of 1:2.09 followed by treatment W_4 (1:1.78) and W_2 (1:1.66).

DISCUSSION

V DISCUSSION

Blackgram is one of the important pulse crops grown in India due to its high nutritional value but its productivity is low during rainy season mainly due to water logging conditions, poor plant stand and excess weed population. The productivity of this crop can be increased remarkably if it is saved from water logging and weeds during rainy season. The present experiment was undertaken to ascertain beneficial effect of providing surface drainage through land configuration methods and weed management practices.

The results obtained in the present investigation are presented in previous chapter. Now, it has been contemplated to discuss the variation observed in details with an attempt to establish the "effect and cause" relationship in the light of available evidences and relevant literature. This chapter of discussion, for the sake of convenience and to derive valid conclusions, has been divided into following heads.

5.1 Effect of weather parameters on crop

5.2 Effect of soil

5.3 Effect of plant population

5.4 Effect of land configuration

5.5 Effect of weed management

5.6 Economics

5.1 Effect of weather parameters on crop

Among the various factors affecting the yield and performance of any crop, the weather conditions play a key role.

It is evident from the meteorological data presented in Table 1 and depicted in fig. 1 that the weather conditions prevailed during the entire crop period were congenial for the normal growth and development of blackgram. No severe incidences of diseases and insect were observed during entire crop growth period. Thus, it is expected that the observed variations in the experimental results were mainly due to the treatment effects only.

5.2 Effect of soil

The data presented in Table 2 indicated that the soil of the experimental plot was low in total nitrogen (0.048%), medium in available phosphorus (32.43 kg ha^{-1}) and fairly rich in available potash (350.00 kg ha^{-1}) and slightly alkaline in reaction (pH 7.8) which is found suitable for raising the blackgram crop.

5.3 Effect of plant population

Initial and final plant populations were not affected significantly due to various treatments (Table 6). It is ascertained from the data that the plant population in all the treatments were uniform which indicated that variation observed in growth and yield attributes as well as in yield were mainly due to treatment effects only and not due to the plant population.

5.4 Effect of land configuration

5.4.1 Effect on growth attributes

Land configuration influenced significantly almost all the growth attributing characters viz., plant height, number of branches per plant, root nodules and dry mater production per plant. Ridge and furrow method of land configuration (L_3) recorded the highest values of all these parameters followed by raised bed (2 plant rows followed by a furrow of 30 cm) (L_2) and flat bed (L_1). This might be due to better improvement in drainage, soil environment, supply of nutrients aeration and root growth under effective land configuration which might be reflected in better growth and development. Almost similar results were also reported by Bajpai and Malik (1976), Rasve *et al.* (1983), Hadvani (1990). Lawand *et al.* (1994), Huliching *et al.* (1994), Zhaojiuzhou *et al.* (1995) and Jain and Dubey (1998).

No significant differences were observed in days to 50 per cent flowering (Table 8) due to land configuration methods.

5.4.2 Effect on yield attributes

Yield attributing characters (Table 11), viz., number of pods per plant, number of seeds per pod and test weight were recorded maximum under ridges and furrows (L_3). The raised bed (2 plant rows followed by a furrow of 30 cm) (L_2) was statistically at par with flat bed method (L_1) with regard to number of pods per plant and test weight. This might be due to the cumulative effect of increased nutrient supply, more porosity and better pod development resulting from ridges and furrows method of land configuration. The findings corroborate the results of Bajpai and Malik (1976), Hadvani (1990), Huliching *et al.* (1994) and Zhaojiuzhou *et al.* (1995).

There were no significant differences observed in number of seeds per pod under different land configuration methods, showing that this is the genetically governed character hence, not influenced.

5.4.3 Effect on yield

The highest seed yield and haulm yield (Table 12) were recorded under ridges and furrows method (L_3) but found at par with raised bed method (L_2). The flat bed (L_1) recorded the lowest seed and haulm yield. The significant differences in seed and haulm yield might be due to better nourishment provided under effective land configuration i.e. ridges and furrows which favourably enhanced root proliferation and aeration facilitating better nodulation and absorption of water along with nutrients resulting in better growth and development ultimately in better seed and haulm yield. Similar results were also obtained by Bajpai and Malik (1976), Hadvani (1990), Mohamed (1991), Huliching *et al.* (1994), Sheikh and Mungse (1998) and Patel *et al.* (2000).

5.4.4 Effect on quality

The results (Table 19) revealed that various land configuration methods did not exert any significant influence on protein content (%). Whereas protein yield (kg ha^{-1}) was significantly influenced by different land configuration methods. The highest protein yield of 222.50 kg ha^{-1} was recorded with ridges and furrows method (L_3) and remained on same bar with method L_2 i.e. (206.79 kg ha^{-1}). The increase in protein yield might be due to higher seed yield under effective land configuration methods.

5.4.5 Effect on economics

Maximum net profit of Rs. 13104.90 ha^{-1} was obtained under ridges and furrows method followed by raised bed method and flat bed method with net profit of Rs. 11755.2 ha^{-1} and Rs. 10562.9 ha^{-1}, respectively. The highest cost benefit ratio of 1 : 2.08 and 1 : 1.81 were recorded under L_3 and L_2 respectively. It was due to higher yields of seed and haulm registered under ridges and furrows method of land configuration. Similar results were also reported by Chauhan (1989), Hadvani (1990) and Jain and Dubey (1998).

5.5 Effect of weed management treatments on growth and yield of blackgram

5.5.1 Effect on growth attributes

Significant differences in plant height, branches per plant and dry matter production per plant were observed due to the effect of various weed management treatments.

Significantly the highest plant height was observed under treatment weed free upto harvest (W_2) followed by treatments two hand weedings + interculturing with hoe at 20 and 40 DAS (W_3) and application of pendimethalin @ 1.00 kg a.i ha^{-1} (W_4). This might be due to asymptotic response in which plants were competiting for light with each other on account of high density i.e. higher crop weed competition. Almost similar results were also reported by Singh and Chaudhary (1992) in greengram.

All the treatments significantly increased the number of branches per plant and dry matter production per plant as compared to unweeded control (Table 8 and 9, respectively). Treatment W_2 (weed free upto harvest) recorded the highest number of branches and dry matter production per plant closely followed by treatments W_3 (two hand weedings + interculturing with hoe at 20 and 40 DAS) and W_4 (Pendimethalin @ 1.00 kg a.i. ha^{-1}). Such results might be obtained due to effective control of weeds under these treatments which reduced crop-weed competition facilitating sufficient space, nutrients and light for better growth in term of higher number of branches and dry matter accumulation per plant. The results conformed the findings of Vats and Sidhu (1976), Singh and Chaudhary (1992) and Singh and Rao (1992) in greengarm and Singh *et al*. (1992), Jain *et al*. (1997) in blackgram.

Days to 50 per cent flowering and number of root nodules per plant (Table 8 and 10, respectively) were remained unaffected due to various treatments.

5.5.2 Effect on yield and yield attributes

Various yield attributes, viz., number of pods per plant, number of seeds per pod and test weight play a vital role in increasing the productivity of blackgram crop.

Almost all the yield attributing characters (Table 11), viz., number of pods per plant, number of seeds per pod and test weight were favourably influenced by various weed management treatments. Treatment weed free upto harvest (W_2) recorded significantly higher number of pods per plant and test weight followed by treatments W_3 (two hand weedings + interculturing with hoe at 20 and 40 DAS) and W_4 (Pendimethalin @ 1.00 kg a.i. ha^{-1}). This might be due to significant reduction in crop-weed competition due to effective control of weeds by these treatments which provided better nourishment reflected in higher number of pods per plant and test weight. Gogoi *et al.* (1992), Singh *et al.* (1992), De *et al.* (1995) and Ramanathan and Chandrashekharan (1998) also reported similar results.

The differences in number of seeds per pod were not significant under different weed management treatments showing that this is genetically governed character hence, not influenced significantly. Similar findings were also reported by Jain *et al.* (1987) in blackgram and Kumar and Kairon (1990) in greengram.

Various weed management treatments were influenced significantly the seed and haulm yield of blackgram (Table 12). Significantly the highest seed yield (1158.37 kg ha^{-1}) and haulm yield (2223.56 kg ha^{-1}) were recorded under treatment weed free upto harvest (W_2) being at par with treatments W_3 (two hand weedings + interculturing with hoe at 20 and 40 DAS), W_4 (Pendimethalin @ 1.00 kg a.i. ha^{-1}) and W_5 (oxyfluorfen @ 0.24 kg a.i. ha^{-1}). The remarkable increase in seed and haulm yield under these treatments (W_2, W_3, W_4

and W_5) might be due to effective control of weeds (Table 14 to 17), reduced dry weight of weeds (Table 18), and higher weed control efficiency (Table 18), which cumulatively facilitated the crop to utilize more nutrients and water for better growth and development measured in terms of various growth attributing characters such as plant height (Table 7), number of branches per plant (Table 8), dry matter production per plant (Table 9) and yield attributing characters such as number of pods per plant and test weight (Table 11). All these parameters showed positive and highly significant influence on seed yield of blackgram. These findings are in close agreement with those reported by Jain and Jain (1987), Gogoi *et al.* (1992), Singh *et al.* (1992), De *et al.* (1995), Modak *et al.* (1995), Jain *et al.* (1997) and Ramanathan and Chandrashekhran (1998).

5.5.3 Effect on weed population

All weed management treatments significantly reduced the population of weeds compared to unweeded control. Treatment of two hand weedings + interculturing with hoe at 20 and 40 DAS (W_3) registered the lowest monocot, dicot and sedges weed population at all the stages of growth (20, 40, 60 DAS and at harvest) which was closely followed by treatment W_4 (Pendimethalin @ 1.00 kg a.i. ha^{-1}). The findings were confined with those reported by Patro and Prusty (1994), Singh *et al.* (1996) in greengram and Singh *et al.* (1992), De *et al.* (1995), Jain *et al.* (1997) and Ramanathan and Chandrashekharan (1998) in blackgram.

5.5.4 Effect on weed dry weight and weed control efficiency

All weed management treatments considerably influenced dry weight of weeds and weed control efficiency.

The dry weight of weeds recorded at harvest were reduced significantly (Table 18) by all the management treatments as compared to unweeded control (W_1). Treatment of two hand weedings + interculturing with hoe at 20 and 40 DAS (W_3) recorded the lowest dry weight of weeds at harvest (280.90 kg ha^{-1}) but remained at par with treatments W_4 (377.30 kg ha^{-1}). Similar results were also reported by Raghvani *et al.* (1987), Singh *et al.* (1992), De *et al.* (1995), Modak *et al.* (1995), Ramanathan and Chandrashekharan (1998) and Choubey *et al.* (1999).

Various weed management treatments showed better weed control efficiency. The highest weed control efficiency at harvest (80.35%) were recorded under treatment W_3 (two hand weedings + interculturing with hoe at 20 and 40 DAS) followed by treatments W_4 (73.60%) and W_5 (67.03%). This might be due to effective weed control achieved under efficient methods of weed management in term of reduced biomass of weeds and higher weed control efficiency. These results were also confirmed the findings of Ramanathan and Chandrashekharan (1998) in blackgram and Patel *et al.* (2000) in greengram.

5.5.5 Effect on quality

The results (Table 19) revealed that various weed management treatments significantly influenced protein content (%)

and protein yield (kg ha^{-1}) in blackgram. The highest protein content of 21.04 per cent was recorded with weed free treatment upto harvest (W_2) being at par with W_3 and W_4 treatments. This might be due to significant reduction in crop-weed competition under effective weed control method which benefited the crop with more nutrient and water reflecting in higher nitrogen content as well as protein content in seeds.

The highest protein yield of 243.89 kg ha^{-1} was recorded with treatment W_2 (weed free upto harvest) followed by treatment W_3 and W_4. The increase in protein yield might be due to higher protein content in blackgram seed and higher seed yield under effective weed management treatments.

5.5.6 Effect on nutrient uptake by crop and weeds

The results on nutrient uptake (nitrogen and phosphorus) by blackgram crop showed that significantly the highest nitrogen and phosphorus uptake by seed and haulm (39.34 and 5.04 kg ha^{-1} and (16.94 and 2.81 kg ha^{-1}), respectively were recorded under treatment weed free upto harvest (W_2), closely followed by treatments W_3, W_4 and W_5. Nutrient uptake by crop was higher under these treatments might be due to better nourishment provided under these treatments as a result of lesser weed population as well as lower dry weight of weeds recorded under these treatments. The findings were in accordance with those reported by Tewari *et al.* (1990), Modak *et al.* (1995) and Choubey *et al.* (1999).

Significantly the highest removal of nutrients (8.04 and 7.12 kg ha^{-1} respectively) by weeds were recorded under unweeded control (Table 21), whereas the lowest nutrient depletion by weeds were recorded under treatments W_3 and W_4. Similar results were also reported by Tewari *et al.* (1990), Modak *et al.* (1995) and Choubey *et al.* (1999).

5.5.7 Economics

The data on total income, total cost of cultivation, net profit and cost benefit ratio (CBR) for various weed management treatments (Table 22) indicated that the highest net profit of Rs. 12296.70 ha^{-1} was obtained under treatment of two hand weedings + interculturing with hoe at 20 and 40 DAS (W_3) followed by W_2 (Rs. 11731.3 ha^{-1}) and W_4 (Rs. 11574.5 ha^{-1}). Similarly the highest CBR was recorded under treatment W_3 (1: 2.09) followed by treatments W_4 (1: 1.78) and W_2 (1: 1.66). These findings were in accordance with those reported by De *et al.* (1995), Mishra and Misra (1996), Jain *et al.* (1997), Ramanathan and Chandrashekharan (1998) in blackgram and Raj *et al.* (2000) in greengram.

SUMMARY AND CONCLUSIONS

VI SUMMARY AND CONCLUSION

A field experiment was conducted during *kharif* season of 2001 on College Farm. N.M. College of Agriculture, Gujarat Agricultural University Navsari Campus, Navsari to study the, "Response of blackgram (*Phaseolus mungo* L. Hepper) to land configuration and weed management practices under South Gujarat conditions". Fifteen treatment combinations consisting of three methods of land configuration i.e. flat bed (L_1) raised bed (2 plant rows followed by a furrow of 30 cm) (L_2) ridges and furrows (L_3) and five treatment of weed management practices, viz., unweeded control (W_1), weed free upto harvest (W_2), Two hand weedings and interculturing with hoeing at 20 and 40 days after sowing (W_3). Pre-emergence application of Pendimethalin @ 1.00 kg a.i. ha^{-1} (W_4) and Pre-emergence application of oxyfluorfen @ 0.24 kg a.i. ha^{-1} (W_5) were evaluated in factorial randomized block design with three replications. The soil of experimental field was clayey in texture, low in total nitrogen and medium in available phosphorus, fairly rich in potash, slightly alkaline in reaction and having good moisture retention capacity.

The blackgram cv. T-9 was sown on 12^{th} June, 2001 and harvested on 8^{th} September, 2001. The crop was fertilized with 20 kg N and 40 kg P_2O_5 ha^{-1}.

The weather conditions were favourable for crop growth and there was no severe incidence of pests and diseases during the

(6) The highest amount of nutrients viz., nitrogen and phosphorus were utilized by seed (35.60 and 4.80 kg ha^{-1} respectively) and haulm (16.57 and 2.48 kg ha^{-1}, respectively) under treatment of ridges and furrow (L_3) clearly followed by method L_2 (raised bed).

(7) Various land configuration methods did not exert any significant influence on protein content.

(8) Significantly the highest protein yield (222.50 kg ha^{-1}) was observed with treatment L_3 (ridges and furrows) followed by method L_2 (raised bed).

(9) Higher net profit of Rs. 13104.90 ha^{-1} with net C.B.R. of 1:2.08 was obtained under method of ridges and furrows (L_3).

6.2 Effect of weed management practices

(1) Plant height was increased notably from 20 days onwards where taller plants were observed under weed free upto harvest (W_2), followed by two hand weedings and interculturing with hoeing at 20 and 40 DAS (W_3) and pendimethalin @ 1.00 kg a.i. ha^{-1} (W_4).

(2) Various weed management treatments did not exert any significant influence on days to 50 per cent flowering and number of root nodules per plant.

(3) The higher values of number of branches per plant, dry matter production per plant, number of pods per plant and test weight were recorded under treatment W_2 (weed free upto harvest) followed by treatments W_3, W_4 and W_5.

course of investigation. The periodical observations on different growth and yield attributes alongwith post harvest observations were recorded.

The experimental results presented and discussed foregoing chapter are summarized and concluded here.

6.1 Effect of land configuration

(1) Amongst the three methods of land configuration, blackgram sown on ridges and furrows method recorded appreciably higher values of almost all growth parameters viz., plant height, number of branches per plant, dry matter production per plant, number of pods per plant and number of root nodules per plant.

(2) Various land configuration methods did not exert any significant influence on days to 50 per cent flowering.

(3) A profound higher values of test weight were noted with ridges and furrows method of land configuration over raised bed and flat bed methods of land configuration.

(4) Significantly the highest seed and haulm yield (1116.33 and 2231.87 kg ha^{-1}, respectively) were obtained under method L_3 (ridges and furrows).

(5) Various land configuration methods did not exert any significant influence on weed population, dry weight of weeds at harvest and uptake of nutrients.

(4) Significantly the highest seed and haulm yield (1158.37 and 2223.56 kg ha^{-1}, respectively) were obtained under treatment W_2 (weed free upto harvest) but remained at par with treatments W_3 and W_4.

(5) The lowest weed population and dry weight of weeds at harvest and higher weed control efficiency were recorded under treatment of two hand weedings alongwith interculturing with hoeing at 20 and 40 DAS (W_3) followed by treatments W_4 and W_5.

(6) The highest amount of nutrients, viz., nitrogen and phosphorus were utilized by seed (39.34 and 5.07 kg ha^{-1} respectively) and haulm (16.94 and 2.81 kg ha^{-1}) under W_2 (weed free upto harvest), closely followed by treatments W_3 and W_4 whereas the lowest uptake of nutrients were noticed under treatment W_3 (two hand weedings + interculturing hoeing at 20 and 40 DAS) followed by treatment W_4. The highest uptake of nitrogen and phosphorus by weeds and the lowest by crop were registered under treatment W_1 (unweeded control).

(7) Significantly the highest protein content (21.04 %) and protein yield (245.89 kg ha^{-1}) were observed with the treatment W_2 (weed free upto harvest) followed by treatments W_3, W_4 and W_5.

(8) From the economics point of view, the highest net profit of Rs. 12296.7 ha^{-1} was obtained from treatment of two hand weedings + interculturing with hoeing at 20 and 40 DAS (W_3) followed by treatments W_2 (Rs. 11731.3 ha^{-1}) and W_4 (Rs.11574.5 ha^{-1})

whereas the highest CBR (1: 2.09) was obtained under treatment W_3 followed by treatments W_4 (1:1.78) and W_2 (1: 1.66).

(9) Interaction effect of land configuration methods and weed control treatments among various growth and yield attributes were found to be non-significant.

CONCLUSION

From the results of one year experimentation, it can be concluded that higher profitable yield of *kharif* blackgram on vertisols of South Gujarat can be obtained by adopting ridges and furrows method of land configuration and by keeping the crop weed free upto 40 days after sowing by two hand weedings and interculturing with hoeing at 20 and 40 days after sowing.

FUTURE LINE OF WORK

In the light of results obtained in this investigation following suggestions are made for future work.

(1) The present experiment should be repeated for two or three years to confirm the consistency of treatment effects.

(2) Study should be conducted under different agro-ecological situations of the Zone to make valid recommendation to the farmers.

(3) Studies should be carried out to study the residual effect of herbicides on soil micro flora as well as on succeeding crops.

(4) Individual or integrated weed management practices may be find out which are eco-friendly and economically viable for sustainable production of blackgram.

BIBLIOGRAPHY

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Ali, M. and Mishra, J.P. (2000). Nutrient management in pulses and pulse-based cropping systems. *Fertilizer News*, **45** (4) : 57-69

Anonymous (1985). SPICS Mini Watershed Programme. *Fertilizer News*, **30** (9) : 54.

Anonymous (1999). A little impetus. The Hindu Survey of Indian Agriculture, pp.61-63.

Anonymous (2000). Nutrient management strategies for the next decade. *Fertilizer News*, **55** (4) : 1-11.

Anonymous (2000). Districtwise Area, production and yield per hectare of Important Food and Non-food crops in Gujarat State. Directorate of Agriculture, Gujarat State Krishi Bhavan, Paldi Ahmedabad-380 006.

Arvadia, L.K.; Patel, C.L. and Arvaida, M.K. (1995). Studies on weed growth and yield of summer greengram as affected by irrigation, weed control and phosphorus. *Indian J. Weed Sci.*, **27** (3-4) : 207-208.

*Bajpai, R.P. and Malik, D.S. (1976). A note on methods of sowing for groundnut. *JNKVV Res.*, **10** (1) : 56-60

*Bayan, H.C. and Gogoi, S. (1998). Influence of weed control measures and phosphorus levels on weed growth, yield and yield attributes of *Kharif* blackgram (*Phaseolus mungo* L.). *Annals Agril. Bio. Res.*, **3** (2) : 167-171.

Bheemappa, A.; Meti, S.K. and Hanchal, S.N. (1994). Effectiveness of broad bed and furrow method of groundnut cultivation as required by farmers. *Karnataka J. Agri. Sci.*, **7** (2) : 201-205.

*Chatterjee, B.N. and Roquib (1977). Bidhun Chandry Krishi Viswa Vidhalaya (Kalyani). *Res. Bulletin*, 3.

Chauhan, D.S. (1989). Studies on the effect of certain non-monetary inputs with cycocel and boric acid on summer groundnut. M.Sc. (Agri.) Thesis submitted to the G.A.U., S.K. Nagar.

Chin, D.V. and Pandey, J. (1991). Effect of pre and post-emergence herbicides on weeds and yield of blackgram (*Phaseolus mungo* L.). *Indian J. Agron.*, **36** : 276-277.

Choubey, N.K.; Tripathi, R.S. and Ghosh, B.C. (1999). Effect of fertilizer application and weed management practices on nutrient uptake by summer blackgram (*Phaseolus mungo* L.) and associated weeds under rainfed condition. *Indian J. Agron.*, **44** (3) : 576-580.

*De, G.C.; Chakraborty, T.; Modak, R. and Das, S. (1995). Efficiency and economics of integrated weed management in chickpea and blackgram. *Indian Agriculturist*, **39** (3) : 213-217.

*De, G.C. and Modak, R. (1993). Integrated weed management in summer blackgram (cv. B-76) in the lateritic tract of West

Bengal. *Proc. Int. Symp. Indian Soc. of Weed Sci., Hissar* November 18-20, Vol. **III** : 150-151.

*Deev, A.A. (1978). Effect of the orientation of ridges on the distribution of total solar radiation and yield of soybean. *Trudy Dal' nevostochnyl Nauchnoissledovatel's* KiiPY No. 74 : 77-81.

Desai, N.C.; Ardeshna, R.B. and Intwala, C.G. (2000). Increasing Pigeonpea Productivity by Providing Land Configuration in Vertisols. *International chickpea and Pigeonpea News letter*, **7** : 17-18.

Dhingra, K.K., Sekhon, H.S. and Tripathi, H.P. (1984). Effect of herbicides for weed control in mungbean. *Indian J. weed Sci.*, **16** (2) : 116-120.

Durrov, V.P. and Egorchenkov, A.I. (1981). Cultivation of soybean on ridges, *Zemledelie*, **12** : 48-49. (*Fide-Fld. Crop Abstract*, **34** (12) : 10095,1981.

*Eckert, D.J. (1990). Ridge planting for row crops on poorly drained soil. *Soil Tillage and Research*, **18** (3) : 181-188.

Gaur, K.C. (1967). Estimation of total soluble salts from soil. Practical Agril. Chem, pp. 64-66.

Gogoi, A.K.; Kalita, H.; Pathak, A.K and Deka, J. (1991). Weed management in blackgram (*Phaseolus mungo* L.). *Indian J. Agron.*, **36** (4) : 601-602.

Gogoi, A.K.; Kalita, H.; Pathak, A.K and Deka, J. (1992). Crop weeds competition in rainfed blackgram (*vigna mungo* (L.) Walp). *Indian J. Weed Sci.*, **24** (3&4) : 81-82.

*Gus, P., Mester, A. and Bogdon, I. (1994). Soil tillage alternatives in the hilly area. *Technologic Modern in Culture Planter De Camp.*, p, 20-21.

Gupta, P.; Kumar, S. and Singh, T. (1984). Soil management to increase crop production. ICAR Pub. New Delhi.

Gupta, Y.K.; Katyal, S.K.; Panwar, R.S. and Malik, R.K. (1990). Integrated weed management in summer mungbean (*vigna radiata* (L.)Wilzeck). *Indian J. Weed Sci.*, **22** (3&4) :38-42.

Hadvani, R.G. (1990). Effect of different methods of sowing and levels of sulphur on growth and yield of groundnut (*Arachis hypogaea* L.) M.Sc. (Agri.) Thesis submitted to the Gujarat Agricultural University, S.K. Nagar.

*Huliching, Dingximing, Yaoyuan and Donglihua (1994). The effect on tillage soil layer environment and soybean root growth of the two ridges and furrow planting pattern. *Soybean Sci.*, **13** (1) : 321-329.

Jackson, M.L. (1967). "Soil Chemical Analysis". Published by Prentice Hall of Indian Pvt. Ltd., New Delhi.

Jain, M.P. and Dubey, A.K. (1998). Productivity and economic viability of soybean with respect to planting system and cultivators in vertisol. *Crop Res.*, **16** (1) : 120-122.

Jain, N.K. and Jain, S.C. (1987). Impact of different weed free media on growth and yield parameters of blackgram (*Vigna mungo* L.) in semi arid tropical conditions. *Indian J. Weed Sci.*, **19** : (1&2) : 20-24.

Jain, V.K.; Chauhan, Y.S. and Chitnis, V. (1997). Effect of cultural and chemical methods of weed management on weed and yield of blackgram (*Phaseolus mungo* L.). *Indian J. Agron.*, **42** (4) : 661-664.

Jayapaul, P.; Uthayakumar, B.; M.M. Devasagayam; B.J. Pandian, Palchamy, A. and A. Balakrishnan (1996). Effect of land configuration method, irrigation regimes and soil moisture conservation amendments on soybean. *Crop Res. Hissar,* **11** (3) : 253-257.

Khade, V.N.; Patil, B.P.; Jadhav, S.N. and Bhosale, S.S. (1997). Effects of irrigation schedules, planting layouts and weed management on the yield of summer groundnut. *J. Maharashtra agric. Univ.*, **22** (1) : 26-28.

Kondap, S.M. and Upadhyay, U.C. (1985). "A practical Manual of weed control". Oxford and IBH Publ. Co.; New Delhi. pp 55.

Kumar, S. and Kairon, M.S. (1990). Studies on crop-weed competition in summer mungbean. *Legume Research*, **13** (3) : 110-112.

Lawand, B.T.; Rajput, S.G.; Kulkarni, R.M. and Patil, V.K. (1994). Effect of planting methods on growth and yield of cowpea under rainfed conditions. *Madras agric. J.*, **81** (6) : 351-352.

Lawand, B.T.; Rajput, S.G.; and Patil, V.K. (1993). Effect of planting methods on growth and yield of cowpea. *Madras agric. J.*, **80** (7) : 407-408.

Meharsing; Phogat, S.B.; Rao, Purshotam and Singh, R.C. (1986). Effect of method of sowing on growth and yield of soybean. *Haryana agric. Res. J.*, **16** (4) : 352-355.

Mishra, M. and Misra, A. (1995). Effect of fertilizer, weed control and row spacing on summer blackgram (*Phaseolus mungo*). *Indian J. Agron.,* **40** (3) : 434-438.

Mishra, O.P. and Singh, G. (1993). Weed management in urdbean (*Vigna mungo* (L.) Hepper). Proc. Int. Symp. *Indian Soc. of weed science, Hissar, November* 18-20, Vol. **III** : 154-155.

Modak, R.; Chakraborty, T. and De. G.C. (1995). Method of weed management on weed biomass, yield of blackgram (*Phaseolus mungo* L.) and nitrogen uptake. *Indian J. Agron.*, **40** (1) : 115-117.

Mohamed, A.K. (1991). Effect of planting method, irrigation and nitrogen fertilizer application on grain yield and yield components of chickpea shendi area sudan Acta Agronomic Hungarida **39** (3-4) : 393-399 (*Fide-Fld Crop Abstr.*, **44** (11) : 8282, 1991).

Olsen, S.R.; Cole, C.V.; Watanabe, F.S. and Dean, L.A. (1954). Estimation of available phosphorus in soil by extraction with sodium bicarbonate, USDA circ., 939 Washington.

Panse, V.G. and Sukhatme, P.V. (1967). "Statistical Methods for Agricultural Workers". Indian council of Agricultural Research, New Delhi.

Parmeswaran, P.; T. Ramnathan and T. Senthival (1987). Moisture conservation technique for rainfed groundnut, sunflower and sesamum. *Seeds and Farms*, **13** (3) : 41-45.

Patel, A.V. and Parmar, M.T. (1989). Note on response of different groundnut varieties to row spacings and land management practices during summer season under middle Gujarat conditions. *G.A.U. Res.*, J., **14** (2) : 86-87.

Patel, C.L. and Patel, Z.G. (1989). Residual effect of herbicides on succseeding legumes. *Indian J. Weed Sci.*, **21** (3-4): 80-81.

Patel, J.C.; Patel, H.D. Patel, M.V.; Amin, A.V.; Patel, B.S. and Patel, M.M. (2000). Response of groundnut to different methods of sowing in sandy soil of North Gujarat. National Symposium on Agronomy : Challenges and strategies for the New Millennium, November 15-18, G.A.U. Campus, Junagadh, pp. 320-321.

Patel, K.R.; Patil, T.D. and Patel, J.B. (1995). Effect of different irrigation schedules and methods of sowing and irrigation on yield, economics, water saving in summer groundnut. *Int. Arachis News Letter*, **15** : 73-75.

Patel, R.B.; Patel, B.D.; Barevadia, T.N.; Meisuriya, M.I. and Trivedi, G.C. (2000). Integrated weed management in greengram. Extended summary: National Symposium on Agronomy : Challenges and Strategies for the New Millennium, November 15-18, 2000, GAU Campus, Junagadh.

Patro, H. and Prusty, J.C. (1994). Integrated weed management in mungbean (*vigna radiata* L.). *Indian J. Weed Sci.*, **26** (1&2) : 79-80.

Piper, C.S. (1950). Soil and plant Analysis. Inter Science Publishing Corporation Inc., New York.

Raghvani, B.R.; Goyal, S.N.; Patel. J.C. and Malavia, D.D. (1985). Weed competition in mungbean. *Indian J. Weed Sci.*, **17** (1) : 18-21.

Raghvani, B.R.; Goyal, S.N.; Patel. J.C. and Malavia, D.D. (1987). Weed management in Blackgram.. *Indian J. Weed Sci.*, **19** (3&4) : 227-229.

Raj, V.C.; Damame, H.S. and Patel, M.P. (2000). Weed management in summer greengram. Extended summary: National Symposium on Agronomy: challenges and strategies for the

New Millennium, November 15-18, 2000, GAU Campus, Junagadh pp. 197-198.

Raju, R.A. (1984). The technology of growing blackgram. Farmer and Parliament. July : 24-25.

Rasve, S.D., Bharambe, P.R. and Ghonsikar, C.P. (1983). Effect of irrigation frequency and methods of cultivation on yield and quality of summer groundnut. *J. Maharashtra agric. Univ.*, **8** (1) : 57-59.

Reddy, M.D.; Reddy, C.N. and Devi, M.P. (1998). Effect of herbicide application on weed control and seed yield of greengram in alfisols during rainy season. *Indian J. Weed Sci.*, **30** (3&4) : 206-208.

Ramanathan, S.P. and Chandrashekharan, B. (1998). Weed management in blackgram (*Phaseolus mungo* L.). *Indian J. Agron.*, **43** (2) : 318-320.

Saxena, M.C. (1978). Management of soybean production under irrigated and rainfed condition. Technology for increasing food production, p. 648-652.

Shah, R.M. (1984). Pulse production in Gujarat State, constraints and opportunities, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Bombay, Calcutta, pp. 69-72.

Shaikh, A.A.; A.S. Jadhav; B.D. Kale and M.J. Wattamwar (1994). Effect of planting layouts, mulching and fertilizers on dry matter accumulation and energy relationship in rainfed pearlmillet. *J. Maharashtra agric. Univ.*, **19** (3) : 421-423.

Sheikh, R.S. and Mungse, H.B. (1998). Influence of planting system, plant population and fertilizer levels on physiological parameters of late sown chickpea. *J. Maharashtra agric. Univ.*, **23** (1) : 73-74.

Shrivastava, U.K. and Pahalwan, R.N. (1972). A preliminary study on method of planting soybean in dry loam soil. *Mysore J. Agric. Sci.*, **6** (4) : 505-506.

Siddiq, E.A. (2000). Rice yawning productivity gaps. The Hindu Survey of Indian Agric., pp.44

Singh, A.N.; Singh, S. and Bhan, V.M. (1996). Crop-weed competition in summer greengram (*Phaseolus radiatus*). *Indian J. Agron.*, **41** (4) : 616-619.

Singh, G.B. and Rao, R.G. (1992). Physiological effect of pre-emergence herbicides in mungbean (*Vigna radiata* L. 'Wilczek). *Annals Agric. Res.*, **13** (4): 401-403.

Singh, K.M.; Singh, D. and Singh, J.N. (1999). Studies on efficacy of clomazone on weeds and summer mungbean (*Vigna radiata* (L.) Wilczek). *Indian J. Weed Sci.*, **31** (3&4) : 258-259.

Singh, R. and Chaudhary, G.R. (1992). Effect of weed control and phosphorus on yield and yield attributes of greengram (*Phaseolus radiatus*). *Indian J. Agron.*, **37** (2) : 373-374.

Singh, R.V.; Parmar, M.L. and Singh, P.P (1992). Response of blackgram (*Phaseolus mungo* L.) to weed control and fertilizer. *Indian J. Agron.*, **37** (1) : 192-193.

Singh, S.; Singh, A.N. and Bhan, V.M. (1995). Studies on the chemical control of seeds in summer mungbean (*Phaseolus radiatus*). *Indian J. Weed Sci.*, **27** (3&4) : 158-159.

Singh, V.K.; Singh, N.P.; Sharma, B.B. and Sahu, J.P. (1998). Effect of planting method and weed control practice on weed management and productivity of pigeonpea in foothills region. *Indian J. Agron.*, **43** (4) : 685-688.

Srivastava, H.C.; Bhaskaran, S.; Menon, K.K.G.; Ramanujan, S. and Rao, M.V. (1984). Pulse production constraints and opportunities. Oxford and IBH publishing Co. Pvt. Ltd., New Delhi, Bombay and Calcutta, pp. 22-24.

Steel, R.G.D. and Torrie, J.H. (1960). "Principles and Procedures of Statistics". Mc-Grew Hill Book Company Inc.

Swaminathan, M.S. (1971). New vistas in pulse production, Indian Agril. Research Institute, New Delhi. Agronomy of Pulses Crops, p. 24.

Swaminathan, M.S. (2000). Natural resources management for an evergreen revolution. The Hindu survey of Indian Agric., pp.15.

Tewari, A.N.; Tiwari, K.N.; Singh, K.K.; Tewari, U.S. and Sharma, J.K. (1990). Effect of weed removal on yield and nutrient uptake in pigeonpea + blackgram intercropping. *Indian J. Agron.*, **35** (4) : 341-345.

Ugale, N.S.; Shinde, S.H. and Jadhav, V.T. (2000). Response of Chickpea cv. 'Vijay' to field layouts and irrigation depths. *J. Maharashtra agric. Univ.*, **25** (1) : 79-80.

Vats, O.P. and Sidhu, M.S. (1976). Critical period of crop weed competition in mung (*vigna radiata* (L.) Wilczek). *Indian J. Weed Sci.*, **8** (1) : 64-69.

Yadav, R.P. and Shrivastava, V.K. (1998). Integrated weed management in blackgram (*Phaseolus mungo*). *Indian J. Agron.*, **43** (1) : 106-109.

*Zhaojiuzhou, Huangcaojun. Heroghua, Wanghaiping and Zangruhquen, (1995). An investigation of the three ridges tillage methods for soybean on an albic soil. *Soybean Sci.*, **13** (4) : 294-301.

*** Original not seen**

APPENDICES

APPENDIX I – N and P_2O_5 content in seed, straw and weed (%) as influenced by various treatments

Treatments	N content (%)			P_2O_5 content (%)		
	Seed	Haulm	Weed	Seed	Haulm	Weed
Land configuration (L)						
L_1 = Flat bed method	3.09	0.73	1.00	0.41	0.11	0.39
L_2 = Raised bed (2 plant rows followed by a furrow of 30 cm)	3.14	0.73	1.04	0.42	0.11	0.41
L_3 = Ridges and furrows	3.17	0.74	1.06	0.43	0.11	0.42
S. Em. ±	0.085	0.008	0.085	0.011	0.005	0.04
C. D. (0.05)	NS	NS	NS	NS	NS	NS
Weed management (W)						
W_1 = Unweeded control	2.98	0.73	0.63	0.38	0.10	0.47
W_2 = Weed free upto harvest	3.37	0.76	0.00	0.44	0.13	0.00
W_3 = Two H.W. + I.C. with hoe at 20 and 40 DAS	3.12	0.74	1.75	0.43	0.11	0.49
W_4 = Pendimethalin @ 1.0 kg a.i. ha^{-1}	3.11	0.73	1.45	0.42	0.11	0.56
W_5 = Oxyfluorfen @ 0.24 kg a.i. ha^{-1}	3.08	0.72	1.32	0.41	0.10	0.52
S. Em. ±	0.066	0.006	0.065	0.009	0.004	0.028
C. D. (0.05)	0.066	0.018	0.065	0.008	0.004	0.08
Interaction						
L x W	N	N	N	N	N	N
C.V %	8.22	3.29	24.55	8.14	14.50	26.02

APPENDIX II : Cost of cultivation (Rs ha^{-1}) of blackgram

Sr. No	Particulars	Cost Rs.
(A) Fixed cost		
1	Land preparation	410
2	Layout, bund forming and opening of channels (8 labours ha^{-1})	320
3	Opening of furrow	150
4	Cost of blackgram seed 12 kg @ Rs 15 kg^{-1}	180
5	Cost of fertilizer	
	(a) Urea 9.46 kg ha-1 @ 244.50 /50 kg	46
	(b) DAP 86.957 kg ha^{-1} @ 445.00/50 kg	774
6	Cost of fertilizer application and sowing of seeds (6 labours ha^{-1})	240
7	Plant protection measures	
	(a) Cost of dusting of methyl parathion + 1 labour	754
	(b) Cost of spraying of spark @ + 1 labour	448
8	Harvesting, threshing and cleaning (18 labours ha^{-1})	720
9	Land revenue Rs. 50/ha /Annum (4 months)	17
Total working capital		4059
10	Interest on working capital @ 12% (4 months)	162
11	Supervision charges @ 10% of total working capital (4 months)	135
Fixed cost		4356
(B) Rates used for cultivation and inputs		
1	Tractor cultivation	110 hr^{-1}
2	Tractor planking	95 hr^{-1}
3	Labour charges for routine agricultural operations	40 day^{-1}
4	Labour charges for spraying herbicides	80 day^{-1}

APPENDIX-II Contd..

(C) Variable cost		
1	Cost of one hand weeding + interculturing with hoeing (15 labours/ha)	600
2	Stomp Rs. 500 lit^{-1} + 2 labour	1827
3	Goal Rs. 2100 lit^{-1} + 2 labour	2305
4	Cost of raised bed and ridges and furrows preparation (25 labours)	1000
(D) Selling rate of produce		
1	Balckgram seeds	15kg $^{-1}$
2	Blackgram haulm	0.50 kg^{-1}

Appendix III : Economics of various treatments

Sr. No.	Treatment combination	Yield (kg/ha)		Realization (Rs/ha)		Gross realization (Rs/ha)	Cost of production (Rs/ha)	Net profit (Rs/ha)
		Seed	Haulm	Seed	Haulm			
1	L_1W_1	600	1543	9006	771.5	9777.6	4356	5421.6
2	L_1W_2	1042	2116	15630	1058.0	16688.0	6756	9932.0
3	L_1W_3	1008	2107	15120	1053.5	16173.5	5556	10617.5
4	L_1W_4	1000	2021	15000	1010.5	16010.5	6183	9827.5
5	L_1W_5	996	1981	14940	990.5	15930.0	6661	9969.0
6	L_2W_1	700	1792	10508	896.0	11403.8	4956	6447.8
7	L_2W_2	1165	2126	17475	1063.0	18538.0	7356	11182.0
8	L_2W_3	1146	2120	17190	1060.0	18250.0	6156	12094.0
9	L_2W_4	1120	2076	16800	1038.0	17838.0	6783	11055.0
10	L_2W_5	1100	2030	16500	1015.0	17515.0	7261	10254.0
11	L_3W_1	750	1883	11245	941.5	12186.8	4756	7430.8
12	L_3W_2	1268	2428	19017	1214.0	20230.9	7156	13074.9
13	L_3W_3	1197	2359	17947	1179.5	19126.6	5956	13170.6
14	L_3W_4	1217	2322	18255	1161.0	19416.0	6583	12833.0
15	L_3W_5	1150	2167	17250	1083.5	18333.5	7061	11272.5

Note : 1. Rate of seed = Rs. 15 kg^{-1} 2. Rate of straw = Rs. 0.50 kg^{-1}
3. Labour wages = Rs. 40 day/labour

CERTIFICATE

This is to certify that I have no objection for supplying to any scientist only one copy any part of this thesis at a time through reprographic process, if necessary for rendering reference services in a library or documentation center.

Place : Navsari.

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(V. S. RATHORE)