

INTEGRATED WEED MANAGEMENT IN GROUNDNUT BASED INTERCROPPING SYSTEM- A REVIEW

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ABSTARCT

Minimizing the crop-weed competition particularly at early stage of groundnut usually encounters with diverse weed flora, the yield could improved upon by about 20-30%. Reduction of pod yield owing to competition with weed depends on the duration of the crop weed competition in general and the stages of crop growth in particular. The yield losses are more pronounced in rain fed crop. When the groundnut fields are kept weed free for a period of at least first 6 weeks there is no significant reduction in pod yield. On the other hand, when groundnut competes with weeds at 4 - 8 weeks the reduction in pod yield is substantial. Effectiveness of weed control is largely dependent on the weed species prevalent, its life cycle and method of propagation. Since mechanical / cultural method alone does not ensure weed free condition, the use of herbicides in combination with cultural methods should be adopted. In areas where agricultural labourer is scarce and costly, herbicides may be used as pre and post emergence application to control weeds. Several studies have shown that the productivity of groundnut is reduced considerably when weed competition occurs during the early stage of the crop. Several workers have reported different critical periods ranging from 30 to 60 DAS revealed that critical period of weed competition was between 2 to 8 weeks after sowing. In general, weed competition in groundnut is more severe for the first 6 weeks from sowing. Several methods have been employed to check the growth of weeds and to improve the crop stand and productivity. From the traditional method of hand weeding and hoeing, modernized methods of weed management is the need of the day through the introduction of herbicides to meet labor shortage to effect early weed control and reduce the cost of weeding. However, no single method has been found to be quite effective in reducing the weed intensity and hence an integrated approach is essential. The integrated method of weed control is found to be more suitable for the management of a broad spectrum of weeds.

Key words: Integrated weed, Intercropping system

Purpose of this Review: Intercropping offers scope for increasing the productivity and monetary return per unit area per unit time. Limited attempts have been made to explore the possibilities of evaluating a suitable crop combination in groundnut based intercropping under different agro climatic conditions. So far, our main emphasis has been on nutrient and weed management in monocropping system. Enough information on weed management under intercropping system has not been generated for adoption. This situation warrants the need for a suitable intercropping system under different weed management practices in groundnut based intercropping system. The available literature on

weed management and intercropping in groundnut are reviewed here under.

1. Intercropping System

1.1 Concept

Intercropping implies growing two or more crops simultaneously in the same area in rows of definite geometrical pattern (De *et.al.* 1978). Saxena (1973) defined this concept as one in which crops of dissimilar growth habits is grown simultaneously in such a way that they do not affect the performance of each other adversely. The crop of longer duration and slow initial growth rate is considered as the base or main crop and the one with shorter duration and

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faster growth rate as the parallel or intercrop. Palaniappan (1985) defined that intercropping is growing of two or more crops simultaneously on the same field and the crop intensification is in both time and space dimensions.

1.2 Intercropping with legumes

In recent years, short duration legumes are intercropped with long and short duration legumes and it is observed that there is no marked reduction in the yield of the base crop. Veerasamy *et.al.* (1974) stated that groundnut and red gram in 6:1 ratio was beneficial than pure stands of either of them. Groundnut and red gram mixture was more profitable than pure crop of groundnut in Bhavanisagar tract (Appadurai and Selvaraj, 1974). Work done under All India Co-ordinated Pulses Improvement Project showed that green gram as an intercrop showed promise than black gram or cowpea in groundnut. (Anonymou, 1977). Saxena *et.al.* (1977) reported that grain legumes such as black gram, green gram and soybean could be successfully grown as parallel crops without affecting the yield of the base crop red gram. Rajah *et.al.*, (1978) observed that groundnut + black gram combination recorded the highest yield, which was even slightly more than that of pure crop. The least depressing effect of black gram and green gram was mainly due to their short duration with lesser smothering effect in the initial stages.

Sripathi (1987) observed that intercropping of black gram with red gram was found more remunerative than either of the sole crops. Sinde *et.al.*, (1990) observed that the yield of groundnut declined with increasing population of red gram and vice versa. The 1:3 row ratio of red gram and groundnut was found to balance their productivity with 500 kg ha⁻¹ of grain of protein from pulse as a bonus production without affecting groundnut pod and oil yields appreciably.

1.3 Intercropping on growth of component crops

The cropping system influences the growth of component crops either favourably or adversely. Mahrotra and Ali (1970) noticed that, in mixed cropping of barley and gram, the height of barley was reduced whereas, gram elongated significantly. Ono and Osaki (1971) observed a reduction in the flower production and the number of mature pods

per plant in groundnut due to shading. Reduction in the number of leaves due to shading had been confirmed by Crookstan *et.al.*, (1975) in *Phaseolus vulgaris*. Gopalasundaram (1976) in his groundnut sunflower mixed cropping study, observed that the height of groundnut was increased in mixed stands while the leaf number; leaf area and number of matured pods were reduced. In an intercropping study with sunflower, Chandrasekaran (1978) observed that shading by sunflower suppressed the growth of cowpea, while it increased the height of groundnut.

1.4 Intercropping on the yield of component crops

Seshadri *et.al.*, (1956) in their groundnut mixed cropping experiment, reported a yield reduction of 21, 24, 27 and 42 per cent with castor, bajra, red gram and sorghum respectively, when compared to sole crop of groundnut. In groundnut-red gram mixture studies, Veerasamy *et.al.*, (1974) observed that groundnut and red gram in the ratio of 6:1 gave yields of 1960 kg of pods and 595 kg of seed ha⁻¹ as compared to 1990 kg of pods in pure stand of groundnut indicating the reduction in pod yield under intercropping system though the over all productivity was higher. Contrary to this, work done under All India Co-ordinated Pulses Improvement Project revealed that pure groundnut gave slightly lesser yield of pods (1136 kg of pods ha⁻¹) than the groundnut intercropped with green gram (1157 kg of pods ha⁻¹) (Anon 1977). Saraf *et.al.*, (1975) reported that intercropping with black gram, urd, cowpea and soybean in red gram did not affect the red gram yield significantly. Hedge and Reddy (1987) observed that association of castor with groundnut and black gram gave comparatively higher castor yields.

Parameswaran *et.al.*, (1988) recorded higher net return in groundnut + mustard intercropping system followed by groundnut sole crop. Sinde *et.al.* (1989) reported that the ratio of 1:3 red gram and groundnut combination registered the highest grain yield as well as pod yield, which was on par with monocropped red gram and groundnut, and was on par with 1:2, 2:2 and 2:4 ratio of red gram and groundnut combination. GajendraGiri (1990) concluded that sole groundnut recorded the highest total productivity (14.90q ha⁻¹) and red gram the

lowest (8.65qha⁻¹) while intercropping of two rows of groundnut in paired planting of red gram three rows in uniform planting of red gram and five rows in red gram were comparable to each other and recorded significantly higher total productivity over sole red gram. These intercropping systems increased the LER by 10 to 19 per cent over sole cropping.

1.5 Nitrogen economy

Janny *et.al.*, (1965) stated that beneficial influence of legume on the associated crops was due to N release as a result of its decomposition of root nodules. In general, the contribution of 'N' in legume would be 10 to 25 kg ha⁻¹. Yadav (1977) showed that groundnut left behind a highly fertile soil suited to raise a good wheat crop with lesser dosage of fertilizers. Laura *et.al.* (1987) stated that the maximum N transfer occurred over a distance of 20 cm in the area of high legume grass ratio. N derived from symbiosis was significantly higher (96 per cent in alfalfa and 92 per cent in trefoil) for legume grown in mixture with grass than for legumes grown in monoculture (86 per cent in alfalfa and 80 per cent in trefoil). Significant N transfer occurred and the amount of N transferred was dependent on inter species distance and legume / grass ratio.

1.6 NPK uptake

The crop yield was closely related to the nutrient uptake. The nutrients removed for production of one tonne of unshelled nuts and one and half tonne of haulms were 71.5, 8.0, 16.5, 27.5 and 5.5 kg of N, P, K, Ca and sulphur respectively (Soundararajan *et.al.*, 1984). According to Asokaraja and Ramiah (1987), N uptake by red gram was significantly increased when black gram was intercropped. Athmanaban (1989) stated that in cropping systems, groundnut + black gram registered higher uptake of nutrients followed by groundnut + green gram. Chinnappan (1978) reported that with sorghum and pearl millet as intercrops, the castor-based multitier cropping system produced greater amount of dry matter and removed more of nutrients from the soil than in legumes as the intercrops. Increasing the quantity of nitrogen applied caused greater removal of nutrient by system with millet as intercrops. In a sorghum based intercropping system, Selvaraj (1978) reported that cowpea and green gram have not reduced the N, P and Ca uptake of sorghum compared to the solid

stand of sorghum and legumes have not also increased the N uptake of sorghum. The total harvest of nutrients from the soil was slightly increased by intercropping with legumes.

1.7 Post-harvest soil nutrient status

Groundnut is estimated to fix 10 to 60 kg N ha⁻¹ in a single season (Dwivedi, 1981). Hence, it leaves the soil richer in nutrient status than a more competitive cereal crop like pearl millet. As a result, the crop-succeeding groundnut is benefited. This was established by the better performance of wheat raised after groundnut than after pearl millet. Muthuvel *et.al.*, (1984) stated that pulse crops fixed up atmospheric nitrogen and evidently there was an increase in the available N status of soil under intercropped treatments. Mahapatra *et.al.*, (1985) observed that the groundnut crop was able to maintain good soil physical conditions and leave significant residual fertility to the second crop. Singh *et.al.*, (1986) reported that soybean and black gram were more suitable for inter cropping than groundnut for increasing NO₃ and NH₄ concentration and population of active bacteria in the maize rhizosphere. This increased maize yield by 15-20 per cent and grain protein content by 20 per cent. Organic carbon content of soil was relatively higher after green gram than initial soil status. This was ascribed to addition of large quantities of leaf, root and nodule biomass and humic substances secreted by roots of green gram.

1.8 Economics of intercropping

In general, intercropping systems have been reported to give higher return than the pure stand of crops. Veerasamy *et.al.*, (1974) reported an extra profit of Rs.611 ha⁻¹ from groundnut-red gram mixture in the ratio of 6:1 over a pure crop of groundnut. According to Saxena *et.al.*, (1977), the total cost of cultivation was slightly higher in parallel cropping by the expenditure incurred on weeding in between intercrops. Experiments conducted under the All India Co-ordinated Pulse Improvement Project showed that pure groundnut gave a net profit of Rs.1204 ha⁻¹. Whereas, when it was intercropped with green gram, black gram and cowpea, the net return obtained was Rs.1461, 1110, 1013 ha⁻¹ respectively (Anon 1977).

Morachan *et.al.*, (1977) concluded that net income per unit area could be increased by

intercropping sorghum with pulses like green gram, black gram and cowpea. Growing pure sunflower gave an income of Rs.518.54 ha⁻¹ Where as, it gave higher income of Rs.1087.05 and 1629.92 ha⁻¹ respectively when raised with cowpea and groundnut (Chandrasekaran, 1978). De *et.al.*, (1978) observed 12.5 per cent yield increase in gingelly + black gram combination. Asokaraja and Ramiah (1987) stated that the yield of groundnut was higher with red gram as intercrop at 2.25 m apart than with cotton or maize. During monsoon seasons, intercropping system involving groundnut + cotton at 1.5 m apart gave higher net income (Rs.6868 ha⁻¹) than pure groundnut (Rs.6134 ha⁻¹). During summer seasons, groundnut + red gram at 2.25 m apart gave higher net income (Rs.6608 ha⁻¹) than pure groundnut (Rs.6482 ha⁻¹). Hedge and Reddy (1987) reported that association of castor with groundnut and black gram gave comparatively higher castor yield. Sinda *et.al.*, (1989) reported that the highest LER of 1.23 was obtained for red gram and groundnut intercropping system in 1:3 row ratio. The monetary return for intercropping of red gram and groundnut in 1:3 row proportions was the most remunerative with a net return of Rs.17053 ha⁻¹ and also the return was higher than growing sole crop of groundnut.

2. Weed management in intercropping

2.1 Weed flora

For formulating effective weed control practice, study of weed flora in groundnut based intercropping system is very important. The weed flora under different locations, seasons, soil types and moisture conditions are discussed here under.

2.1.1 Seasons

Agasimani *et.al.*, (1978) observed that during winter season *Chenopodium album* Linn., *Anagallis arvensis* Linn. *Asphodelus tenuifolius* Caven, were the predominant weeds, while during summer, *Trianthema monogyna* Linn., *Cyperus rotundus* Linn., *Cynodon dactylon* Pers. *Echinochloa colonum* Link, and *Eleusine aegyptica* Desf, were predominant. During kharif season, *Euphorbia thymifolia* Linn., *Cynodon dactylon*, *Tribulus terrestris* Linn., *Trianthema monogyna* and *Convolvulus arvensis* Linn., were the major weeds associated with groundnut (Verma and Jaiprakash, 1977). Sesaiah *et.al.*, (1979) observed

predominance of *Cyperus rotundus* to the extent of 90 and 64 per cent of the weed population and dry weight respectively during summer. Kondap *et.al.*, (1980) observed *Lagasca mollis* Cav., *Celosia argentea* and *Panicum repens* Linn., as predominant weeds in kharif groundnut. Abundance of *Eleusine indica* Desf., *Digitaria sanguinalis* Scop., *Echinochloa crusgalli*. *Physalis minima* Linn., *Croton sparsiflorus* Morang., *Celosia argentea* and *Heliotropium indicum* Linn. In the rabi season, groundnut was reported by Patro *et.al.*, (1981). Kavani *et.al.*, (1988) reported that the weeds viz. *Brachiaria distachya* (L) Stapf., *Cynodon dactylon* (L) Pers, *Dactyloctenium aegyptium* (L.) wild., *Digitaria Ciliaris* (retz) *Eragrostis tenella* L.P. Beauv. *Cyperus rotundus* (L.) *Leucas aspera* (wild) were predominant in red gram groundnut intercropping system in Telungana regions of Andra pradesh in kharif season. In Kanpur under sandy loam soil conditions, the dominant weeds viz. *Echinochloa colonum*, *Elusine indica*, *Dactyloctenium aegyptium* L., *Digitaria Sanguinalis* L., *Trianthema monogyna* L., *Commelina benghalensis* L., *Solanum nigrum* L., *Euphorbia hirta* L., *Phyllanthus niruri* L., *Cyperus rotundus* L., were observed in groundnut + red gram and red gram + intercropping system in summer season (Tiwari *et.al.*, 1989 and 1990).

2.1.2. Soil type

Echinochloa colonum, *Digitaria sanguinalis*, *Dactyloctenium aegyptium* Beauv., *Chloris barbata* Sw., *Panicum repens* and *Eragrostis* sp. in grasses, *Cyperus rotundus* in sedges and *Amaranthus viridis* Linn., *Boerhaavia diffusa* Linn., *Phyllanthus niruri* Linn., *Phyllanthus maderaspatensis* Linn., *Portulaca oleraceae* Linn., *Tridax procumbens* Linn., *Digera arvensis* forst., *Euphorbia hirta* Linn., and *Trianthema Portulacastrum* Linn., in broad leaved weeds were found to occur in groundnut under in red sandy loam soils (Kulandaivelu and Sankaran, 1976; Anon., 1983). In medium black soils, *Cynodon dactylon*, *Cyperus* sp, *Convolvulus arvensis*, *Eleusine indica*, *Chloris barbata* Sw., *Echinochloa crusgalli* Linn., and *Anaphalis cutchica* Clarke, were the predominant weeds (Patel and Raghavani, 1980).

2.1.3. Moisture conditions

Under irrigated condition, *Echinochloa colonum*, *Dactyloctenium aegyptium*, *Chloris barbata* *Panicum repens*, *Eragrostis* sp and *Cyperus*

rotundus were the predominant monocots and *Amaranthus viridis*, *Portulaca oleraceae*, *Tridax procumbens* and *Euphorbia hirta* Linn. were the dominating dicots (Kulandivelu *et.al.*, 1978; Anon, 1983). During the early stages of the crop, *Cyperus rotundus*, *Dactyloctenium aegyptium*, *Echinochloa colonum* and *Commelina benghalensis* Linn., in monocots and *Celosia argentea* and *Celosia polygonoides* Retz. in dicots were the predominant weeds observed under irrigated condition (Soundararajan *et.al.*, 1981). They also observed the predominance of *Digitaria sanguinalis*, *Panicum repens* and *Chloris barbata* from about 45 days of the age of crop.

Karthikeyan (1984) reported that the weeds namely *Echinochloa colonum*, *Trianthema portulacastrum*, *Cleome viscosa*, *Cyperus rotundus*, *Cyperus iria*, *Eclipta alba* and *Dactyloctenium aegyptium* are the dominant weeds under Periyar Vaigai Command area of Tamil Nadu. Dominating weed flora under rain fed condition were *Cyperus rotundus* and *Cynodon dactylon* in monocots and *Euphorbia hirta*, *Phyllanthus niruri* and *Amaranthus viridis* in dicots (Elangovan and Gopalsamy, 1978).

2.1.4 Location

Bhan *et.al.*, (1983) found that *Echinochloa colonum*, *Cyperus iria* Linn., *Dactyloctenium aegyptium*, *Brachiaria ramosa* Staff and *Commelina benghalensis* were the predominant annual weeds at Pantnagar. In Punjab, *Celosia argentea* was the most prevalent weed in groundnut (Gill and Brar, 1973). In Andhra Pradesh, *Cyperus rotundus* was the predominant weed (Soundararajan *et.al.*, 1976). Studies by Jain *et.al.*, (1984) showed that *Cynodon dactylon*, *Cyperus rotundus*, *Panicum sp.*, *Dinebra arabica* Jacq., *Digitaria sp.* and *Commelina sp.* were more common weeds in groundnut at Khargore regions. *Echinochloa colonum* and *Trianthema portulacastrum* was the dominating weeds flora at Periyar Vaigai command area (Karthikeyan, 1984). In Bhavanisagar area, *Boerhaavia diffusa* was the predominant weed in groundnut fields (Suresh, 1984). *Echinochloa colonum* and *Trianthema portulacastrum* were the dominant weed species in groundnut field at Agricultural College and Research Institute, Madurai (Muthukumaran, 1985).

2.1.5 Weed competition

Groundnut crop germinates slowly and it takes 7-12 days for the first leaf to appear above the soil and grows slowly there after. These factors help the weed to compete with the crop and dominate it, considerable losses are seen when the weeds compete with the crop during the initial stages of crop growth. The severity of weed infestation, critical period of weed competition and losses caused by weeds are reviewed here under.

2.1.5.1 Critical period of competition

The productivity of groundnut is reduced considerably when weed competition occurs during the early stage of the crop. Several workers have reported different critical periods ranging from 30 to 60 DAS (Krishnamurthy *et.al.*, 1981; Rajan *et.al.*, 1982; Malik and Bhan., 1983, Ragavani *et.al.*, 1984; Patel *et.al.* 1985; Kalaiselvan *et.al.*, 1987; Singh *et.al.*, 1988. Soundararajan *et.al.*, 1976; Drennan and Jennigns 1977; Gowda *et.al.*, 1977; Yaduraju *et.al.* 1981; Gaudham 1984; Tiwari *et.al.*, 1989) revealed that critical period of weed competition was between 2 to 8 weeks after sowing. In general, weed competition in groundnut is more severe for the first 6 weeks from sowing.

2.1.5.2 Effect on crop morphology

Crop weed competition, being the dominating factor in limiting the productivity, have an influence on the morphology of crops. At high weed intensity, pegging is inhibited in groundnut (Brar *et.al.*, 1973). Weed free plots showed an increase in number of branches as compared to weed-infested plot (Gangule and Khuspe, 1962; Karthikeyan, 1984 and Suresh, 1984). Increased number of branches per plant by the application of Lasso at 2.51 kg ha⁻¹ was reported by Singh *et.al.* (1980). The leaf area index and number of compound leaves were influenced by weed control treatments. LAI was high at 75 DAS (Jadhav and Narkhede, 1980). Weed free environment increased the number of branches in groundnut (Iwata and Takayanagi, 1980 and Anon, 1983). Dry matter accumulation was reported to increase up to 90 DAS under weed free conditions, Absolute growth rate per week was highest during 46-60 DAS (Jadhav and Narkhede, 1982).

2.1.5.3 Effect on soil moisture

The competition for moisture is more severe under rainfed condition than under irrigated condition. Delay in maturity of the crop due to competition for water in dry condition at the end of the season was reported by Singh and Moolani (1967). Increase in soil moisture in weed free condition was observed by many workers (Gangule and Khuspe, 1962; Hill and Santleman, 1969). The effective utilization of available moisture especially in water scarce condition can be obtained by weed control.

2.1.5.4 Effect on nutrient status of soil and crop uptake

Management of weeds enables the crop to utilize the nutrients in soil by better uptake by the crop without any competition by weeds. Weeding becomes essential when farmyard manure is applied as it serves as source of weed seeds (Gangule and Khuspe, 1962). Prabhakara setty and Hosmani (1975) reported a high negative correlation between nitrogen uptake by weeds and crop without weed control practice. At recommended dose of fertilizers, groundnut yield was reduced up to 42 per cent (Thimmegowda and Krishnagowda, 1977). Doubling of nutrient uptake by groundnut due to weed free condition compared to the unweeded conditions was observed by Naidu *et.al.* (1982). They also observed that nutrient removal by weeds was more up to 75 days. Sessaiah (1978) observed an increase in nutrient uptake by groundnut with fluchloralin application. Soundrarajan *et.al.* (1981) reported that N, P, K required to produce one quintal of groundnut can be halved under weed free condition and this was more pronounced under rainfed than irrigated condition. Weed control increased the nutrient uptake by groundnut crop (Kondap *et.al.*, 1980; Anon., 1983). Kondap *et.al.*, (1985) observed that nutrient uptake by weeds was more in bunch varieties of groundnut than in spreading varieties. Weed control through hand weeding and herbicides increased the nutrient uptake by the crop and decreased the uptake by weeds (Yadav *et.al.*, 1986). Jeyakumar *et.al.* (1987) concluded that chemical and cultural weed control markedly enhanced NPK uptake by the crop. Kavalappa *et. al.* (1988) opined that herbicide treatments, hand weeding and hoeing reduced weed growth and also reduced the loss of nutrients 2 to 3

fold. Girijesh and Patil (1989) observed that weed control treatments registered a significant improvement in the uptake of nutrients by groundnut crop as compared to control.

2.1.5.5. Effect on yield attributes and quality characters

Major yield contributing factors are pod number per plant, shelling percentage and kernal weight. These factors are affected considerably due to weed infestation. Increased pod number per plant due to weed control was reported by several workers (Singh *et.al.*, 1980; Kulandaivelu and Sankaran, 1985; Anon., 1983; Soundararajan, *et.al.*, 1984b). Reduction in pod number per plant due to delayed weeding (40-60 days) and impaired ripening of pods due to seed infestation were reported by Hammerton (1976) and Iwata and Takayanagi (1980) respectively. Increased pod weight per plant due to weed control was reported by several workers (Prabhakara setty and Hosmani, 1975; Naik *et.al.*, 1977, Verma and Jaiprakash, 1977). Increase in kernal weight through weed control was observed by Balanarasaiah *et.al.*, (1969) and Verma and Jaiprakash (1977). Soundararajan *et.al.*, (1984a) were able to get increased shelling outturn by weed control in groundnut. Increase in oil content through weed control was reported by Chandra Singh *et.al.* (1977).

2.1.5.6 Effect on crop yield

The yield reduction due to weed competition with groundnut has been reported to range between 20 and 90 per cent at varying intensities of competition (Brar *et.al.*, 1980; Kondap *et.al.*, 1980. Shah and Meisheri, 1980; Yaduraju *et.al.*, 1980; Anon., 1983, Malik and Bhan 1983). Yield reduction in groundnut due to weeds was more than other yield limiting factors under rainfed condition. Different weed control treatments resulted in 117 to 313 per cent and 24 to 119 per cent increased yield over weedy check in red gram and groundnut respectively (Anonymous., 1987). Tiwari *et.al.*, (1990) stated that in black gram and red gram intercropping systems, weed free conditions increased the seed yield by 60.3 per cent in red gram and 84.3 per cent in black gram.

2.2 Weed Control methods

Several methods have been employed to check the growth of weeds and to improve the crop

stand and productivity. From the traditional method of hand weeding and hoeing, modernized methods of weed management is the need of the day through the introduction of herbicides to meet labour shortage to effect early weed control and reduce the cost of weeding. However, no single method has been found to be quite effective in reducing the weed intensity and hence an integrated approach is essential. The integrated method of weed control is found to be more suitable for the management of a broad spectrum of weeds.

2.2.1 Cultural method

The cultural methods involve land preparation, hand hoeing and weeding, time of sowing, spacing, seed rate, mulching, cropping system and manuring. Rangiah *et.al.*, (1976) showed that weed regeneration was higher in hand weeding than the other cultural methods. Traditional cultural practice of hand hoeing and weeding was comparable with herbicides (Singh *et.al.*, 1980). Two hand hoeing and weeding were considered to be effective for controlling weeds and for higher yields (Yadav *et.al.*, 1986; Kulandaivelu and Sankaran, 1985). Abraham and Singh (1986) stated intercropping of cowpea and green gram in groundnut markedly suppressed the growth of monocotyledonous weeds, viz. *Echinochloa sp* and *Dactyloctenium aegyptium* and had no effect on dicotyledonous weeds. Balakrishnan and Rajendran (1987) stated that allelopathy, the release of phytotoxin metabolites secreted by intercrops was probably a natural mechanism in certain crops for weed suppression.

2.2.2 Chemical method

In agriculture, chemical control is gaining importance due to labour shortage at the times of peak agricultural operations and also due to reduced cost of weeding. Chemical method of weed control was found to be superior over cultural methods due to its effective weed control in initial stages of crop, thereby minimizing the competition for nutrient, water etc. (Prabhakara setty and Hosmani, 1975). Several herbicides have been developed, tested and herbicide applied as pre plant sand mix, pre emergence or post-emergence spray for controlling weeds in groundnut based intercropping system.

2.2.2.1. Pre-Emergence herbicides

2.2.2.1.1 Fluchloralin

Kulandaivelu *et.al.* (1978) found that pre-emergence application of fluchloralin gave effective control of *Trianthema portulacastrum*, *Euphorbia hirta*, *Amaranthus viridis*, *Cyperus rotundus* and *Cynodon dactylon*. About 45 per cent weed control efficiency was obtained when the herbicide was applied at 2.5.1 ha⁻¹ (Bhan *et.al.* 1983). Narayana Rao and Mahadeva Gupta (1981) observed the lowest weed population with fluchloralin at 2.0 kg and 1.25 kg ha⁻¹. Soundararajan *et.al.*, (1981) reported effective control of narrow leaved weeds like *Dactyloctenium aegyptium* and *Echinochloa sp* due to fluchloralin application. Jain *et al* (1984) noted that fluchloralin was less effective on grasses, but controlled broad leaved weeds. Work done under All India Co-ordinated Research Programme on weed control revealed that fluchloralin (0.75 and 1.0 kg ha⁻¹) was effective on annual grass weeds like *Echinochloa colonum*, *Digitaria Sanguinalis*, *Dactyloctenium aegyptium* and *Panicum repens* which were the predominant weeds in groundnut, sown in red soil and irrigated by canal water (Anonymous. 1989).

2.2.2.1.2 Pendimethalin

Pendimethalin was the most promising pre-emergence herbicides for weed control in groundnut (Carson, 1979 and Kulandaivelu and Sankaran, 1985). Effectiveness of pendimethalin on broad-leaved weeds was reported by Singh *et.al.* (1980) and Jain *et.al.*, (1984). Yadav *et.al.*, (1986) found that pendimethalin at 1.0 to 1.5 kg ha⁻¹ was effective in the control of *Echinochloa colonum* and other weeds in groundnut. Effective control of *Eragrostis sp.* *Eleusine aegyptium*, *Cleome viscosa* and *Diodea teres* with pre-emergence application of pendimethalin was also reported by Mehra *et.al.* (1987). Work done under All India Co-ordinated Research Programme on weed control revealed that the herbicide pendimethalin (1.0 and 1.5 kg ha⁻¹) was effective in controlling the annual grass weeds (Anonymous. 1989).

2.2.3 Integrated approach

2.2.3.1 Cultural + Fluchloralin

Yaduraju *et.al.*, (1980) reported that fluchloralin at 1 kg ha⁻¹ followed by one hand weeding was more effective than the herbicide alone

at higher ratio. Pre-emergence fluchloralin at 0.75 kg ha⁻¹ followed by one hand weeding controlled the weeds satisfactorily and registered higher yields (Anon, 1983). Similar findings with different doses of fluchloralin have been reported by Tosh and Jena (1983), Belorker *et.al.*, (1984), Panwar *et.al.*, (1984), Raghavani *et.al.* (1984), Bhola *et.al.*, (1985), Suresh (1984) and Pannu Rajkumar (1986). Malavia and Patel (1989) revealed that there was a marked decrease in weed population and increase in pod yield with increases in frequencies of cultural practices. In case of herbicide application, weed density increased markedly with advancement of age of crop. All the herbicides applied as pre-emergence spray controlled weed population up to 30 DAS. The effect of fluchloralin on pod yield was more or equal to one hand weeding on 30 DAS. Hence it has been suggested that pre-emergence herbicide spray followed by one hand weeding is ideal for effective control of weeds.

2.2.3.2 Cultural + Pendimethalin

It was observed that pre-emergence application of pendimethalin followed by one hand hoeing and weeding checked the weed growth (Anon., 1983). Pendimethalin at 0.75 to 1.5 kg ha⁻¹ with one hand weeding gave the most effective

weed control and produced yield similar to those under weed free condition (Bhola *et.al.*, 1985).

CONCLUSIONS

In recent years, short duration legumes are intercropped with long and short duration legumes and it is observed that there is no marked reduction in the yield of the base crop. Intercropping systems have been reported to give higher return than the pure stand of crops. The results from different studies revealed that significantly higher dry pod yield and monetary returns were obtained from integrated weed management and mechanical method of weed control. However, application of herbicides alone did not control the weeds effectively. The pre-emergence application of herbicides like pendimethalin @0.75 kg a.i./ha + one hand weeding (15 DAS) + one hoeing (30 UAS) gave better results. The first hand weeding or harrowing in groundnut is usually done at 25 days after sowing and is repeated once or twice depending upon the weed situation. Beyond 45 days of sowing no weeding is done to avoid damage to the growing peg and developing pods. For controlling fresh flush of weeds appearing relatively at later stages, use of herbicides plus hand weeding is found effective.

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