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Weed Control Measures in Greengram – a Review

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Abstract

Greengram is the third most important pulse crop in India. Weeds are a major limiting factor in production of greengram that lead to a drastic reduction in yield. Weed management is very important in successful cultivation of greengram. Due to its slow growth during early stages, weeds grow abundantly and interfere with the crop for uptake of water and nutrients. They also limit the availability of light and space for the crop. Weeds mature earlier than the crop and shed their seeds in soil, thereby, increasing weed seed bank in the soil. Naturally more hardy and competitive, they cause significant yield losses if not controlled properly. Weed infestation is one of the major constraints in greengram cultivation and causes 50 to 90% yield loss. Yield losses in crops due to weeds depend on several factors such as weed emergence time, weed density, type of weeds, and crops, etc. Among the various factors responsible for poor yield in greengram is an inadequate weed control measure. Weeds have to be controlled for successful crop production. Significant crop losses due to weeds are simply not acceptable in a world where two billions more people will have to be fed in the next 40 years. The traditional practice of hand weeding requires dependence on the increased number of labor during the peak period of sowing and harvesting and becoming expensive. However weeding through implements i.e., the mechanical way is economical and time saving; it is not satisfactory in a broadcast or mixed cropped area. For effective and timely weed control in crop plants use of herbicides with proper liable techniques has become a common practice. While herbicide application initially inhibits soil microflora, populations rebound with the passage of time due to degradation of herbicides. Integration of herbicides with HW generally provides efficient weed control without any negative influence on symbiosis, growth, yield and nutrient uptake of greengram. Based on the resource available to have to adopt the best suitable weed control strategies like cultural control, mechanical methods, herbicide adoption, and integrated approaches will significantly decrease the weeds, which will lead to even greater yields. Finally, integrated weed management is the key to sustainable crop production throughout the world and will remain the mainstay for weed control for the foreseeable future.

Keywords: *Greengram, yield loss, weed flora, crop weed competitid, critical period, nutrient uptake, grain yield, quality loss, weeds control, manual method,cultural control, mechanical methods, herbicide, Integrated weed managment*

Introduction

Greengram is the third most important pulse crop in India. It is the cheapest source of dietary protein. It is consumed in various forms as whole or split, husked and unhusked. It is rich in protein, carbohydrates, fat, amino acids, and vitamins, and also provides a large quantity of green fodder which serves as the nutrition food for the livestock. It can be grown in all seasons of the year. Green gram improvessoil health and maintains its environment. Hence it can be grown as a sole crop, intercrop, mixed crop and in sequential cropping systems.

Among the various factors responsible for poor yield in green gram is an inadequate weed control measure. Weed infestation is one of the major constraints in green gram cultivation and causes 50 to 90% yield loss [24]. Competition with the weeds leads to 30 to 80% reduction in grain yield of green gram during summer and *kharif*seasons while 70-80% during *Rabi* season respectively [3]. Weed control is one of the essential agronomic measures to exploit the maximum

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yield potential of newly developed high yielding varieties [44] reported that the weed infestation if not checked within 20 DAS there would be a severe yield reduction to an extent of 38 percent in contrast to 20 percent yield reduction with unchecked weed infestation till 20 DAS in green gram. The traditional practice of hand weeding requires dependence on the increased number of labor duringthe peak period of sowing and harvesting which becoming expensive [57]. However weeding through implements *i.e.,* the mechanical way is economical and time saving; it is not satisfactory in a broadcast or mixed cropped area. For effective and timely weed control in crop plants, use of herbicides with proper liable techniques has become a common practice. A higher rate of herbicides may leave residue [14] to succeeding crops. The use of herbicides in conjunction with cultural practices or other practices would make complete control of weeds and will be acceptable by the poor farmer [5]. Hence, the development of integrated weed management is economically viable as well as ecologically safe for effective weed control and enhances the productivity of green gram.

Common weed spectrum in greengram field

Weed flora in greengram crops differs from region to region with soil conditions. Generally, weeds are found in larger numbers with a more aggressive nature, because of their wider adaptability even under extremities of climate, edaphic and biotic stresses. The high persistence nature of weeds is attributed to their ability of high seed production and seed viability. One should have good knowledge about the persisting weed flora for better management to gain more yield. The information on the weed spectrum of green gram fields is essential for the formulation of effective weed control strategies. The major weed flora found in greengram under sandy loam soil of Rajendranagar, Andhra Pradesh were *Cynodon dactylon, Dactyloctenium aegyptium, Celotia argentia, sedges viz. Cyperus rotundus and* broad-leaved weeds *viz. Digera arvensis, Trianthema portulacastrum, Commelina bengalensis, Parthenium hysterphorus, Euphorbia hirta, Hemidismus indica* [34]. Similarly, in the sandy loam soil of Naida (West Bengal), the experimental field was dominated by following weed flora such as Ageratum *conyzoids, Boreria hispida, Commelina banghalensis*, *Echinochloa colona, Cynodon dactylon, Paspalum scrobiculatum, Digiteria sanguinalis* and*Cyperus rotundus* [53].

In the deep black soils of Navsari Agricultural University, Navsari (Gujarat) the weed flora consisted of *Cyperus rotundus*, *Echinochloa crusgalli, Digitaria sanguinalist, Sorghum halepense, Cynodon dactylon, Amaranthus viridis, Alternanthera sessillis, Digera arvensiss* and *Convolvulus arvensis*. In medium black soil of Junagarh, Gujurat*Panicumcolonum*L., *Cynodondactylon*L., *Cyperusrotundus*L., *Digeraarvensis*Forsk, *Euphorbia hirta*L., *Leucas aspera* Spreng., *Phyllanthus niruri* L., *Portulaca oleracea*L., *Indigoflora glandulosa*L., *Phyllanthus niruri* L. were found [8].

Under clay loam soil of Dharwad, Karnataka; broad leaved weeds (BLW) like *igera arvensis* Forsk, *Amaranthus viridis*L., *Commelina benghalensis*L., *Cyanotis cucullata*L., *Phyllanthus niruri*L., and *Argemonemexicana*; grasses like *Brachiaria eruciformis*L., *Cynodon dactylon*L., *Digitaria sanguinalis*L. and *Dinebra retroflexa*L., and sedge *Cyperus rotundus*L. are dominant [46]. *Amaranthus spinosus, Digera arvensis*,*Trianthema portulacastrum*, *Gisekiaporedious*, *Euphorbia hirta*, *Aristidadepressa*, *Portulaca oleracea*, *Cenchrus biflorus*, *Cleome viscosa*, *Tribulus terrestris*, *Corchorus tridense*, *Cyperus rotundus*, *Eleusine verticillata*, and *Aervato mentosa*were the dominant species under loamy sandy soil of Bikaner, Rajasthan [22]. In sandy loam soils of Ludhiana, Punjab *Cyperus rotundus and Trianthema portulacastrum*was the major weed flora found in summer green gram [18].

Crop weed competition

The life cycle of most weeds coincides with that of the crop they invade, thus ensuring the mixing of their seed with those of the crops [29]. Due to diversity, weeds are a major threat to agriculture and they out-compete crops for natural resource utilization [8]. Crop weed competition has been established as a major limiting factor for its low productivity causing yield reductions to the extent of 40 to 80 percent depending upon the type and density of weed species present in the field.

Weeds, being naturally hardy and emerging faster, cause severe competition at an early stage of the crop in respect of light, nutrients, water, and space reflecting in a considerable reduction in crop yield. Thus, it becomes essential to study crop-weed competition scientifically and how it can be reduced to the maximum [38]. Crop need a weed free period of the first 30 days, as the crop is short stature and suffers badly if weeds are not controlled at early stage

[31]. Weed competition with mungbean persisting for 20-30 days after emergence was very critical and prolonged competition resulted in substantial yield reduction [33].

Weed competition is very severe during the rainy period, particularly at the early stages (30 to 45 days after sowing) of the legume crops and hence early weed control is essential [2].

The initial 45 day period is considered to be a critical period concerning crop weed competition in green gram [49]. In general, competition between crops and weeds was more severe when the competing plants have similar vegetative habits and demands upon resources.

Effect of weed management on Grain yield

Weeds compete withcrop plants for all the resources required for growth like space, water, sunlight and air, and cause a reduction in crop yield. Depending on weed type and crop weed competition, it reduces crop yield up to 96.5% [55], whereas the loss of mung bean yield due to weeds ranges from 65.4 to 79.0% [13]. Weed competition reduces the grain yield of summer green gram by 34.9% during the initial first 30 days after sowing, thereafter it increases to 49.15% [49]. The Competition with the weeds throughout the crop season reduced the seed yield of mungbean by 83.3% [30]. The weeds infestation if not checked after 20 DAS, severe yield reduction to the extent of 38 per cent was recorded in contrast to 20 per cent yield reduction with unchecked weed infestation till 20 DAS.

Nutrients

Nitrogen (N), phosphorus (P), and potassium (K) are the primary plant nutrients required for plant growth. When crop growth is interfered by weed growth, it reduced the nutrient utilization of crop plants. In general, weeds have a larger nutrient requirement and will absorb as much or more than the crop. In the same way, the adoption of weed management practices significantly enhanced NPK uptake by the green gram and reduced removal of nutrients by weeds as compared to that of unweeded checks [8]. Weeds removed 61.9, 12.1, and 51.3 kg/ha of N, P_2O_5 and K_2O kg/ha respectively in weedy plots [22]. [51] reported that decreased nutrients uptake by the crop was noticed with an increase in severity and duration of weed infestation.

Quality of grain

A heavy infestation of weeds hampers not only the growth and yield as well as infest the quality of the pod or seed. The protein content of green gram is significantly influenced by weed management practices. Unweeded check reduced the protein content to 18.26 in greengram [8] compared to the adoption of two hand weeding and two intercultural at 20 DAS & 40 DAS (22.15%) and oxyfluorfen @ 0.180 kg/ha + 1 hand weeding at 30 DAS (21.87%). The experiment laid out on summer mungbean at Pantnagar (Uttaranchal) and noted that protein content was significantly higher in weed free plots and the lowest in the weedy check plot. Harmoniously, the weed species are affecting the quality of pod size and seed due to the long time presence of weed growth and also reducing the market value of produces [12]. Thus, weed flora as well as the weed population in unweeded control plots affected the quality adversely. Weed management strategies in greengram

Weed free crop situation has created a stable place to crop for getting effective growth in environmental circumstances. Besides causing crop losses, weeds are also responsible for reducing crop quality, nutrient status of soil, etc. The weeds can be checked by adopting various methods like eco-physical, biological, chemical and recently through combining direct and indirect approaches *i.e.* integrated weed management. Wherever, select the weed control techniques based on the economic threshold levels of weed growth for providing weed free competition and also reduce the environmental biodiversity [1].

Manual Methods

In India, weeds are controlled mostly either manually or mechanically in green gram. Manual weed control techniques manage weed populations through physical methods that remove, injure, kill, or make the growing conditions unfavorable. Hand weeding at 20-25 DAS and followed by another weeding at 12-15 DAS interval up to 50-55 days of the crop. One of the important methods of hand weeding by hoe is effectively controlling the weed species, especially *Cyperus rotundus*in the inter row spaces of a line sown crop. This method might proovide good physical and environmental conditions to crop growth by way of soil aeration through the stirring of the soil. Still, now, this method could be effective for eliminating weeds, particularly annual and biennial weeds in cropped and non-cropped situations. Hand weeding

at 20, 30 and 40 DAS reduced weed infestation most efficiently throughout the growing period of the crop and as a consequence, it produced the highest seed yield of summer green gram [9].

Hand weeding at 20 and 30 DAS and hand hoeing at 20 and 30 DAS enhanced the yield of greengram by 3.4%, 3.6% over the weedy check [7].[37] reported that at Akola, Maharashtra, hand weeding + 1 hoeing increased the grain yield by 68.9% over control. Removal of weeds using inteculturing and hand weeding at 20 and 40 DAS reduced the weed population, dry weight of weeds and improved the weed control efficiency, yield attributes, yield and protein content in greengram. For all that, lower weed biomass, lesser weed density, weed index and weed control efficiency were observed with hand weeding followed by mechanical weeding in both greengram and blackgram [54].

Mechanical Methods

In the recent past, weed control is affected more by chemical means supplemented by mechanical weeding. Increasing demand for labor and escalating cost of agro-chemicals together with phytotoxicity effects pose the farming community to think of mechanical measures, which will help crop production to free itself from the scourge of weed menace with limited labor [17]. Mechanicalweedingcanbedonebyunskilled-labourandisgenerally economical, non-polluting without residual problems, and is relatively safe to the operator.

In the past, there were no mechanical weeders to fight this enemy and the farmer had to use his hands to pull them out. Manual weeding is laborious, back breaking and time consuming and hence efficient mechanical weeders are being developed for weeding operations and help to obtain expected yields from the farm. Although it has undergone aspectacular advancement, to use of simple weeders with hand weeding and it would be easily opertaed, economically more effective in controlling the weed flora and led to anincrease the productivity of crops. Rotary weeder was effective in controlling weeds present in inter-row space, but failed to control the weeds in intra-row space or those in the vicinity of the crop [10]. Similarly [28], the use of improved weeders increased yield from 169.5 percent to 329.6 percent over control.

Mechanical control of weed controls because of physical changes in the immediate environment may cause positive or negative effects. The suppression of the targeted weeds will open niches in the environment and may also stimulate the growth of other weeds by decreasing their competition and making their environment more favorable. If a desirable plant does not fill the niches, it will eventually be taken over by another weed.

Cultural Methods

Weed control is one of the most important objectives of cultural operations. Following proper cultural operations is more than half the weed control envisaged on a farm. While directly it includes a healthy growth of crops, indirectly it maintains a crop environment that is detrimental to weeds. Among the crop management practices, the method of planting plays a major role in controlling weeds. The reduction of *E. Colona* in bed planting of green gram may be due to more foliage growth of bed planted green gram which caused hindrance in the germination of weeds and deeper burial of weed seeds during the formation of raised beds.

Munching can suppress weeds, due to delayed emergence and smothering effect on weeds, especially on broad leaves as compared to grassy weeds [40]. In green gram, dust mulching significantly reduced the weed dry weight and density which resulted in more uptake of nutrients by the crop and finally increased the yield [56]. Besides various methods of weed control. A good crop cover by adopting right inter-row and intra-row spacing will smother the growth of the weeds.

Chemical Methods

Hand and mechanical control methods are used on a large scale but, cost is very high, unfavorable weather and soil conditions and also the labors are not available at the proper time. The chemical control of weeds is found to be effective and economical in the initial stages of growth. The use of herbicides has gained impetus from the general rise in farm wages for consistently increasing the economic levels of farms as well as providing non-farm employment opportunities, and drastically use of herbicide as a result of rising opportunity costs of labor across the developing world [2]. Effective weed control depends on the proper selection of herbicides, type of weed flora infesting the crop, the time of application, and further use of the optimum dose of herbicide [11].

Pre emergence herbicide

Pre emergence herbicide is preferred because of its better efficiency along with time involvement. Also, it causes no mechanical damage to the crop that happens during manual weeding [32]. Pre-emergence herbicides are applied one or two days after the sowing of a crop but before the emergence of crop. Major pre-emergence herbicides *viz.,* Pendimethalin, Oxyfluorfen, Fluchloralin, Clethodium, Terbutryn, etc are used to control the germination of weeds in green gram at early stages.

Application of pendimethalin as pre emergence @1.5 kg/ha along with hand weeding at 30 DAS observed maximum weed control efficiency leading to an increase the productivity of greengram [7]. In the same way, pre emergence application of pendimethalin at 1.50 kg/ha in combination with raised seed bed and ridge planting was effective to control *Polygonum alatu* and *Ageratum conyzoides* [23]. Pre emergence application of pendimethalin @ 1.00 kg/ha or imazethapyr 100 g/ha in green gram reduced weed density and dry weight [27]. The pendimethalin was ineffective against sedges and lost its efficacy after 20 days of application against grasses and broad leaves. Application of pendimethalin + imazethapyr provided effective control of all the grass weeds and created weed free conditions till the first 40 days of sowing [19]. Glyphosate spraying on zero tillage condition at 7 days before sowing plus one hand weeding at 25 days after emergence would be economic for mungbean production, besides reducing the density of *Echinochloa crusgalli, Digitaria sangunalis* and *Cyperus rotundus* [21].

Post emergence herbicides

The use of post-emergence herbicides alone or in combination may broaden the window of weed management through broad spectrum weed control [35]. Recently, some new post emergence herbicides *viz*. Imazethapyr, Acifluorfen sodium and Clodinafoppropargyl, Quizalofop ethyl, Fenoxaprop-p-ethyl, Cyhalofop-butyl *etc*. are being marketed with the assurance of selective control of weeds in green gram.

The imazethapyr allows much flexibility in the timing of the applications. Imazethapyr may be applied as pre-plant initiation, pre-emergence or as post-emergences [59]. Although, [43] application of fenoxaprop-p-ethyl @ 60 g/ha effectively controlled the predominant weeds like *Echinocloa colonum* and *Paspalum distichum* and recorded significantly lower weed dry matter and higher grain yield.

Application of quizalofop-ethyl @ 0.040 kg/ha (WCE 36.70 percent) was most effective in controlling weeds followed by fenoxaprop-p-ethyl @ 0.075 kg/ha (WCE 36.70 percent) [8]. Similarly, the application of Quizalofop-p-ethyl @ 50 g *a.i.* ha^{-1} at 21 DAE + hand weeding at 28 DAE recorded lower dry weight of grasses and sedges [25]. The combinations of Haloxyfop-p-methyl at 135 g/ha + Imazethapyr at g/ ha, and Quizalofop ethyl at 50 g/ha + Imazethapyr at 75 g/ha were applied at 12-15 days after sowing of a green gram as an early post emergence can be recommended for weed control in green gram [39]. The maximum weed control efficiency was recorded under Imazethapyr 200 g/ha (89.26 percent) and Imazethapyr 100 g/ha (83.65 percent) and higher weed smothering and higher yield of green gram [45]. Pendimethalin 0.75kg/ha as pre emergence + imazethapyr + imazamox 40 g/ha at 30 DAS as a post-emergence application in summer green gram reduced weed density and weed dry weight [22]. The post emergence application of imazethapyr at0.075 kg/ ha applied 20-25 days after sowing was the most remunerative and effective herbicide for controlling the complex weed flora in mungbean [20]. Similarly, post emergence application of Imazethapyr @ 100 g ha^{-1} with raised panting of green gram recorded maximum weed control efficiency [58]. Under constraints of labor availability, maximum yield, net profit and effective weed control in green gram crop can be achieved with the application of Imazethapyr or Quizalofop-p- ethyl 100 g/ha 15-20 days after sowing was reported [4]. However, [26] reported that imazethapyr at 75 g/ha was effective against both monocot and dicot weeds and was at par with one hand weeding at 20 DAS, however, it was more effective against grassy weeds. If enhanced the grain yield by 45.3 percent over the weedy check.

Integrated weed management strategies

Nowadays, various weed control methods were found to be effective in controlling weeds in greengram, and also its each other methods have their own merits and demerits based on resource availability or environmental condition. However, efficient and cost-effective weed control can be achieved by using either a combination of herbicides or combining herbicides alone or any one of the weed control methods may not control the weeds effectively. In

such conditions, an integrated weed management (IWM) practice involving both chemical and other agronomic manipulation may be an efficient tool, as increasing crop density seems to be an alternative to shift crop weed competition in favor of crop.

An integrated weed management practice involving both chemical and other agronomic manipulation may be an efficient tool, as increasing crop density seems to be an alternative to shift crop weed competition in favor of crop [47].

In general, sequence application of weed control methods like pre emergence herbicide prevents or kill the germinated weed seeds and further vigour weed growth was controlled by hand weeding for superior methods than the individual application of other control methods of weeds [42]. Initial pre emergence application of pendimethalin @ 1 kg *a.i.*/ ha and followed by one manual weeding minimize total weed density throughout the crop growth period and produces maximum yield [55]. In the same way, the application of quizalofop-p-ethyl @ 50 g a.i. ha^{-1} at 21 DAE and followed by one hand weeding at 28 DAE produced the highest yield attributes, seed yield and benefit: cost ratio in mungbean cultivation compared with the application of herbicide alone [25]. Application ofoxyfluorfen 0.180 kg/ha followed by one hand weeding at 30 DAS significantly superior in reducing the density of monocot and dicot weeds [8]. Application of pre emergence herbicides as pendimethalin (1.00 kg/ha) or oxyfluorfen (0.18 kg/ ha) followed by mechanical weeding (hand weed + inter cultivation or two hand weeding at 20 and 40 DAS respectively) creating a better weed free situation and also provides economically safe to farmers [6]. Crop grown under line sowing with the application of quizalofop ethyl @ 50 g/ha recorded lowest weed dry weight followed by the broad bed method and ridge method. However, pre-mix application of imazethapyr + pendimethalin (1000 g/ha) or imazethapyr + imazamox (pre-mix) 70 g/ ha reduced total weed population by 63.2 and 62.3 per cent, respectively so given as better performance of the combination of herbicides might be due to synergistic effect between the two herbicides reducing the population as well as dry matter accumulation of different weed species [42].

Regulation of various weed control methods should be such that they give a competitive edge to crop over weeds. The continuing dependence on a single method of weed control leads to shift of weed flora in favour of more tolerant and difficult to control species and to tackle this problem, there is a need to adopt integrated weed management practices. The rising cost of labour and input will wipe out the profits of farmers unless an integrated approach with the focused attention of ecology and herbicides is adopted.

Conclusion

The above stated review results reveal that, weeds have to be controlled for successful crop production. Significant crop losses due to weeds are simply not acceptable in a world where two billions more people will have to be fed in the next 40 years. Based on the resource available to have to adopt the best suitable weed control strategies like cultural control, mechanical methods, Herbicide adoption and integrated approaches or indivual, will significantly decrease the weeds, which will lead to even greater yields. Finally, integrated weed management is the key to sustainable crop production throughout the world and will remain the mainstay for weed control for the foreseeablefuture.

Future Scope of the study

Weeds are the most important biotic constraints to agricultural production in both developing and developed countries. To develop effective and sustainable weed management tactics, knowledge of weed biology and ecology is very important. Challenges confronted by the weed researchers are many and multi-pronged with limited opportunities requiring a concerted and multi-disciplinary effort to tackle the future weed problems. Some of the important emerging areas which require intensified and in depth research efforts are the effect of global climate change on crop-weed interactions, protocol development for weed risk analysis, weed management in precision as well as organic agriculture, herbicide tolerant crops (HTCs), and use of remote sensing techniques in weed management and variable rate technology for herbicide application. Proper weed management technologies can result in an additional income of Rs. 1,05,036 crores per annum prorate, which can increase the share of agriculture in India's GDP by 15%. Thus, the increase in agricultural productivity will eventually result in significantly increasing the country's overall GDP and its growth rate. The socio-economic status of the farming community especially the rural poor will improve. Our environment will be clean and native biodiversity will be preserved. At

the end, proper weed management would strengthen the food security scenario and also alleviate the fears of food insecurity in the country by resulting in significantly increased food production.

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