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Review Article

WEED MANAGEMENT STRATEGIES IN BLACKGRAM (*Phaseolus mungo* L.): A REVIEW

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Abstract- Blackgram (*Phaseolus mungo* L.) is one of the important pulse crops grown in India, which belong to the family "Leguminoseae". It is consumed in various forms as whole or split, husked and unhusked. It is rich in protein, carbohydrate, fat, amino acids, vitamins, and also provides large quantity of green fodder which serves as the nutrition food for the livestock. The number of factor responsible for low productivity (receives low fertilizer input, moisture, pesticides, poor quality seed etc.,) of blackgram, among that factors most important but not recognized factor liable for poor yield due to inadequate weed control. Weed offer severe competition to their crop during early stage of growth and reduce the yield ranges between 27 to 90 per cent due to uncontrolled weed growth. However, different weed control methods like cultural, physical/mechanical, biological and chemical management practices to effectively controlled weeds. Hence, physical/mechanical methods of weed control was achieved by hand weeding or any small weeder (twice) at 20 and 40 DAS not effectively because of high labour wages, continuous rainfall and non-availability at peat period of crop weed competition. Now days, more number of herbicides are available for controlling many weed species very effectively. When in fact, high quantity of herbicides are applied into soil it will contaminating the soil fertility, soil living organisms etc. finally led to damage or affect the life's of plants, wildlife and even human beings. Keeping these points in view, more population of weeds at later stage of Blackgram pleas for a suitable combination of various weed control techniques to achieve maximum benefits through minimum yield loss and reasonable weed control to the sustainable crop production.

Keywords- Weeds, Weed control, Blackgram, Integrated weed management.

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Introduction

Blackgram is grown all over the world, mostly in tropical and sub-tropical countries for grains, green manuring, fodder and forage as sole crop, intercrop, mixed crop and in sequential cropping systems. The low levels of availability of legume grains in India could be mitigated not only by increasing the production but also by minimizing the quantitative and qualitative losses of grain by weeds through their control [1]. As the crop itself getting less attention, weed control is more neglected and further reduces the production. Weeds infestation is 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 [2]. Weed control is one of the essential agronomic measures to exploit the maximum yield potential of the newly developed high yielding varieties. The need for adequate weed control measures is emphasized by the fact that weeds cause more damage to crops than all plant pests and diseases put together [3]. The time-honored practice of hand weeding is usually carried out only after sufficient damage by weed to crop has already been done to the crop. Moreover hand weeding, which is becoming expensive. This requires dependence on increased number of labour during peak period of sowing and harvesting [4]. Though weeding through implements is economical and time saving, it is not satisfactory in a broadcast or mixed cropped area. Solution for these hurdles use of herbicides with proper liable techniques has become a common practice for early effective and selective weed control in crop plants [5]. Herbicides now available are capable of controlling many weeds very effectively. However, in tropical countries like India, a wide spectrum of weed flora is observed. Higher rate of herbicides may leave residue [6] to succeeding crops. Further the continuous use of herbicides may eliminate all the weed species and their place may be taken over by some resistance ones, or the existing ones may develop resistance. All these eventualities have to be borne in mind when secured herbicides like resort to chemical weeds control. 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 [7]. The intensity of weeds at later stage of the blackgram calls for a suitable combination of physical, chemical, cultural, mechanical, and possibly biological weed control techniques to achieve maximum benefits through minimum yield loss and reasonable weed control [8]. Development of integrated weed management that is economically viable as well as ecologically safe is of at important to control the weed effectively and improve the productivity of blackgram.

Common weed spectrum in blackgram field

The spectrum of weed in blackgram differs widely with environment and soil conditions. Generally, weeds are found in larger numbers with more aggressive nature, because of their wider adaptability even under extremities of climate, edaphic and biotic stresses. The blackgram crop with wide range of weeds species of grasses, sedges and broad leaf weeds while various weeds flora, grassy weeds are dominating after that broad leaved weeds has offer a competition for crop weed condition of environment factors or soil fertility. High persistence nature of weeds is attributed to their ability of high seed production

and seed viability. The information on the weed spectrum of blackgram fields is essential for the formulation of effective weed control strategies. Here under, dominant weed flora associated with blackgram field in various environmental region is shortened. The major weed flora in blackgram under silty clay loam conditions were *Echinochloa colona, Cyperus iria, Digitaria sanguinalis, Panicum dichotomiflorum, Commelina benghalensis, Polygonum alatum* and *Ageratum conyzoides* [9]. Whereas, [10] the sandy loam soil of Kandi area, was dominated with the weed flora of *Eleusine aegytiacum* (23 per cent), *Cyperus rotundus* (15 per cent) and *Cynodon dactylon* (4 per cent) among grasses and *Digera arvensis* (40 per cent) and *Commelina benghalensis* (10 per cent) among broad leaved weeds observed in rainfed blackgram. In the sandy loam soils of Tirupati, the weeds reported were *Dactyloctenium aegyptium, Digitaria sanguinalis, Cynodon dactylon, Panicum repens, Cyperus rotundus, Celosia argentea, Cleome viscosa, Digera arvensis, Euphorbia hirta, Phyllanthus niruri, Portulaca oleracea* and *Trianthema portulacastrum* were observed in Blackgram [11].

Similarly, [12] concluded that *Echinochloa crusgalli, Echinochoa colona, Cyperus rotundus, Cynodan dactylon, Cleome viscosa* etc. were the major weed flora observed in the experimental field of black gram in rice fallow condition at Killikulam, Tamil Nadu. [13] noticed that in the clay soil, the dominant weed flora of broad leaved weeds were *Gnaphalium polycaulon, Nasturtium indicum, Chrozophora rottleri, Cardanthera uliginosa, Xanthium strumarium* and in grasses were *Echinichloa colona, Dinebra retroflexa, Lepochloa chinensis*in blackgram. In sandy clay loam soils of Bapatla, the dominant flora observed in rice fallow blackgram were *Vicia sativa, Cardiospermum halicacabum,Chrozophora rottleri, Phyllanthus madraspentesis, Granea maderaspatana* and *Xanthium strumarium* [14]. However, Krishna western delta of Guntur, the dominant weed flora of the field consisted of *Echinichola colona* with more than 80 per cent of the weed population and other weed species like *Echinochola crusgalli, Leptochloa chinensis, Panicum xylopodium vari etc*. [15].

[16] observed major weed flora were narrow leaved weeds *Echinochloa spp. Cynodon dactylon* and *Cyperus rotundus* the sedge; and *Parthenium hysterophorus, Amaranthus viridis* and *Trianthema portulacastrum* among the broad leaved weeds in *kharif* sown blackgram.In sandy loam soil of Naida (West Bengal), the experimental field was dominated with following weed flora such as*Ageratum conyzoids, Boreria hispida, Commelina banghalensis*, *Echinochloa colona, Cynodon dactylon, Paspalum scrobiculatum, Digiteria sanguinalis* and *Cyperus rotundus* [17]. The experimental field was mainly colonized by *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Cyperus rotundus*, *Cleome viscosa* and *Physalis minima* in blackgram [18].In 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 *Convolvulvulus arvensis* [19].

Crop weed competition

Crop weed competition has been established as a major deterrent for its low productivity causing yield reductions to the extent of 40 to 80 per cent depending upon type and density of weed species present in the field. Crop type and soil properties had the greatest influence on the occurrence of weed species. The type of irrigation, cropping pattern, weed control measures and environmental factors also had a significant influence on the intensity and infestation of weeds [20]. Weeds, being naturally hardy and emerge faster, cause severe competition at an early stage of crop in respect of light, nutrients, water and space reflecting in considerable reduction in crop yield. Thus, it becomes essential to study crop-weed competition scientifically and how it can be reduced to maximum [21]. Weed emergence in this crop during the first week is quite high. The initial 4 to 5 weeks are considered to be crucial for weed crop competition in urdbean. Competition between plants is maximum when available resources for crop growth become limiting [22]. In general, competition between crops and weeds was more severe when the competing plants have similar vegetative habits and demands upon resources.

Critical period of crop weed competition

The association of weeds occurs naturally with crop growth period, still need to catch out the exact time when the weeds are reducing the maximum crop productivity which as period or stage as 'critical period of crop weed competition. In this, situation or condition is the best for effectively manage or control the weed species with real weed control techniques. The adverse effect of weeds on black gram would be severe in the early growth stages as in other short duration crops [23].

The critical period of weed competition in pulses crops is generally during the first 30 DAS. According to [24] concluded that the reduction in the yield duo to weed competition was throughout the cropping period (46.8 per cent). When weedy conditions were maintained for first 20, 30 and 40 DAS reduction in blacgram grain yield was 4.1, 22.1 and 44.7 per cent respectively. The maximum crop weed competition in blackgram was observed during the period from 10 to 30 DAS [25]. In summer Blackgram, maximum crop weed competition occurred during the period up to 30 DAS. An initial period of 20 to 40 days is very critical and season long weed competition has been found to reduce blackgram yield to the extent of 87 per cent depending on the type and intensity of weed flora [26]. When in fact, [4] weed free situation was kept for 30 to 45 DAS to prevent the potential loss in blackgram grain yield. Therefore, it can be revealed that crop-weed competition period in blackgram from 15-45 DAS.

Effect on yield

Weeds are majorly compete with crops by moisture, nutrients, sun light and space at critical growth period it leads to reducing the yield of blackgram. Hence, more effect of weeds on crops will be discussed hereunder.

Yield

Blackgram is one of the crops sensitive to weed competition. Among all the crop pest and diseases, weeds alone are responsible for about one third yield loss in crop production. Nevertheless, [24] the reduction in the yield due to weed competition throughout the cropping period was 46.8 per cent. When weedy conditions were maintained for first 20, 30 and 40 DAS, which was reduced the grain yield (4.1, 22.1 and 44.7 per cent, respectively) of summer blackgram. Most likely, [27] the reduction in yield due to the infestation of *Cuscuta* in blackgram cultivars varied from 12.7 to 39.3 per cent. The weeds infestation if not checked after 20 DAS, severe yield reduction [2] to the extent of 38 per cent was recorded in contrast to 20 per cent yield reduction with unchecked weed infestation till 20 DAS. Almost certainly, *Echinichloa* was reported to be a dominant weed and yield reduction upto 53 per cent was reported duo to uncontrolled weed growth in rice fallow blackgram [15].

Nutrients

Nitrogen (N), phosphorus (P) and potassium (K) are the primary plant nutrients required for plant growth. When the crop growth is interfered by weed growth, it reduced the nutrient utilization of crop plant. In general, weeds have a larger nutrient requirement and will absorb as much or more than the crop. In the same way, [28] 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_2O_5 and 16.9 to 54.3 per cent K_2O. Weeds removed 33.53, 15.78 and 72.19 kg/ha of N, P_2O_5 and K_2O kg/ha respectively in weedy plots [29]. On the other hand, [30] and [31] weed growth particularly *Echinichloa spp*. is severe and effectively competitive with the crop for residual moisture, nutrients and reduces the blackgram yield upto 75 per cent.

Quality of grain

A heavy infestation of weeds hampers not only the growth and yield as well as infest the quality of pod or seed. Protein content of blackgram significantly influenced by weed management practices. Significantly the highest (22.76 per cent) and the lowest (21.90 per cent) protein content were observed with pendimethalin @ 1.0 kg/ha along with one hand weeding and inter culturing at 20 DAS, respectively [32]. However, [33] 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 weedy check plot. Harmoniously, the weed species are affecting the quality of pod size and seed due to long time presence of weed growth and also reducing the market value of produces [34]. Thus weed flora as well as weed population in unweeded control plot affected quality adversely.

Weed management strategies in blackgram

Weed free crop situation has creating stable place to crop for getting effective growth environmental circumstance. 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 [35]. The popular or effective weed management strategies to find out the weed species, weed control methods, time of scheduling to be practiced. In this context, decrease or minimize weed growth may be use of cultural, physical or mechanical and herbicides application have been improved in growth and spread of weeds.

Manual methods

In India, weeds are controlled mostly either manually or mechanically in blackgram. 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 method of hand weeding by hoe is effectively controlling the weed species in the inter row spaces of a line sown crop. This method might be provides good physical and environmental condition to the crop growth by way of soil aeration through 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. Respectively, [36] the minimum seed yield was recorded when weeds were allowed to grow throughout the crop season and yield was highest in weed free plots received hand weeding twice at 20 and 40 DAS. Similarly, [37] the first hand weeding at 20 DAS and followed by another weeding at 40 DAS received more seed yield of 1860 kg/ha.

Hand weeding recorded significantly the highest yield (1120 kg/ha) of Blackgram due to effectively reduced the density of weed species and also its dry weight at critical crop growth period [38]. In the same way, [39] two hand weeding tremendously increased the seed yield and yield parameters of blackgram. 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 blackgram and greengram [40] .Two hand weeding at 15 and 40 DAS was found to be more effective in controlling weed species in blackgram and it led to higher seed yield and yield attributes, weed control efficiency, net profit, benefit cost ratio and lowest weed index were observed by [14]. Application of 20 kg N/ha as basal plus 20 kg N/ha as split at 30 DAS plus two hand weeding (30 and 45 DAS) recorded the more number of pods/plant (24.96), number of seeds/pods(7.47) and 1000 seed weight (38.34 g) in Blackgram [41].

Mechanical methods

In the recent past, weed control is affected more by chemical means supplemented by mechanical weeding. Increasing demand for labour and escalating cost of agro-chemicals together with phytotoxicity effects pose the farming community to think of mechanical measures, which will help the crop production to free itself from the scourge of weed menace with limited labour [42]. Mechanical weeding can be done by unskilled labour and is generally economical, nonpolluting without residual problems and is relatively safe to the operator.

In the past, there were no mechanical weeders to fight this enemy and 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 operation and help to obtain expected yields from the farm. Although it has undergone a spectacular advancement, to use of simple weeders with hand weeding and it would be easily operating, economically more effective in controlling the weed flora and led to increase the productivity of crops [25]. 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 vicinity of the crop [43]. Similarly [44], use of improved weeders increased yield from 169.5 per cent to 329.6 per cent over control.

Mechanical control of weed controls because physical changes in the immediate environment that 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, they 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. Blackgram is highly sensitive to abiotic stresses and thus, its yield levels are usually low. Among the production factors known to determine the crop yield, date of sowing has been recognized as the most important non-monetary input affecting the growth and yield in view of the change in the environmental conditions. The optimum time of sowing ensures the complete harmony between the vegetative and reproductive phases on one hand, and the climatic rhythm on the other and helps in realizing the potential yield [45].

Weed population and weed dry weight were 16 and 12per cent lower, respectively, in line sowing than broadcast sowing of blackgram [5]. While, [46] application of mulches reduce the weed infestation, increase the soil temperature and conserve the soil moisture in the field. Planting the crop at optimum time therefore, plays a key role in obtaining high seed yields [47]. The reduction in weed population and less dry matter production of weeds may be due to an appreciable smoothing effect on weed as broad bed method leaving very little space weed to grow offered better crop weed competition in favour of crop resulting higher grain yield of urdbean [48]. 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. Crop rotation also affects weed population in the preceding crops like maize or sorghum [46].

Chemical methods

In reality, crop fields are seldom adequately weeded by hand; weeding is tedious and time consuming. Laborers are not always available when needed. Weeding is often done late, causing drastic losses in yield. Due to scarcity of labour at peak times of agricultural operations, different herbicides based weed management technologies have been developed and as an alternative and test verified [49].

Chemical weed control by pre-sowing, pre-emergence and post-emergence application of herbicide and combinations of them are all effective way to control weeds for first few weeks after sowing of crop [50]. The use of herbicides has gained impetus from the general rise in farm wages for consistently increase the economic levels of farms as well as provide the non-farm employment opportunities, and drastically use of herbicide as a result of rising opportunity costs of labour across the developing world [51].

Based on income and labour use per hectare, herbicide technology was found superior to various weed control strategies. To create an awareness or knowledge to farmers about the proper use of pre and post emergence herbicide techniques to controlling weed flora in blackgram.

Pre emergence herbicides

Pre-emergence herbicides are applied one or two days after sowing of a crop but before the emergence of crop. Although the emergence of crop is taken into consideration, the emergence of weeds is equally important for designating many herbicides pre-emergent. Several pre-emergence herbicides *viz.,* Pendimethalin, Oxyfluorfen, Nitrofen, Alachlor, Clethodium, Terbutryn, Fluchloralin,etc to control the germination of weeds in Blackgram at early stages.

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 [52]. Moreover, the control is more effective as the weeds even within the rows are killed, which invariably escape, because of morphological

similarity to crop, during mechanical control. Effective weed control depends on the proper selection of herbicides, type of weed flora infesting the crop, time of application and further use of optimum dose of herbicide [8]. Application of pendimethalin as pre emergence @1.5 kg/ha along with hand weeding at 30 DAS observed maximum weed control efficiency it lead to increase the productivity of Blackgram [53]. 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* [9] and improving the physiological parameters (dry matter production, leaf area index and chlorophyll content) and further develop the nodules in urdnean were significantly influenced by fluchloralin @ 1.0 kg/ha followed by pendimethalin @ 0.75 kg/ha [52].Almost certainly, application of pendimathali (0.75 kg/ha) plus hand weeding at 30 DAS drastically reduced density and dry weight of *Trianthema monogyna* [54]. Congruently, pendimethalin @ 0.75 kg/hain integration with one hand weeding at 45 DAS resulted in highest seed yield of blackgram and minimum weed number and dry matter accumulation as observed by [55]. However, the highest seed and haulm yield as influenced by pendimethalin at 0.75 kg/ha as pre emergence along with one hand weeding at 40 DAS in summer Blackgram [56]. Harmoniously, effective suppression of newly emerging grasses and broad-leaved weeds by the application of pendimethalin after dibbling of black gram seeds [57].

Post emergence herbicides

The use of post-emergence herbicides alone or in combination may broaden the window of weed management by broad-spectrum weed control [58]. Recently, some new post emergence herbicides *viz*. Imazethapyr, Acifluorfen sodium and Clodinafop propargyl, Quizalofop ethyl, Fenoxaprop-p-ethyl, Cyhalofop-butyl *etc*. are being marketed with the assurance of selective control of weeds in blackgram. The imazethapyr allows much flexibility in timing of the applications. Imazethapyr may be applied as pre-plant initiation, pre-emergence or as post-emergences [59]. Although, [60] application of fenoxaprop-p-ethyl @ 60 g/haeffectively controlled the predominant weeds like *Echinocloa colonum* and *Paspalum distichum* and recorded significantly lower weed dry matter and higher grain yield. Similarly, post-emergence application of tralkoxydin @ 0.4 kg/ha and fenoxaprop-p-ethyl @ 80 g/ha at 30 DAS recorded significantly lower weed dry weight, weed density and recorded higher weed control efficiency and grain yield of rajmash on clay loam soil [61].

In rice fallow Blackgram, thiobenthiocarb at 2.0 kg/ha as sand mix application at 9 DAS was more effective with 70 per cent weed control efficiency and recorded the highest yield of 385 kg/ha and was on par with imazethapyr at 63.5 g/ha applied as post emergence on 20DAS [62]. Weed control efficiency of fenoxaprop-p-ethyl applied @ 75 g/ha was found to be higher than that of fenoxaprop-p-ethyl applied @ 45, 60 g/ha and provide effective control of *Echinocloa colonum*and *Echinocloa crus-galli* on clay loam soils of Pantnagar [63]. However, [64] 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 per cent over weedy check. Application of imazethypyr @ 63 g/ha resulted in minimum dry weight of sedges and broad leaved weeds and also registered highest grain yield (930 kg/ha) in Blackgram [22]. In the same way, [12] observed that the effect of imazethapyr on weed density, weed dry weight and weed control efficiency was at par when applied either on 21 or 28 DAS. The post- emergence herbicides like fenoxaprop-p-ethyl, clodinafop-propargyl and cyhalofop-butyl significantly reduced *Echinochloa colona* growth and increased blackgram yield by 27 to 42 per cent over weedy check without any crop injury [23]. The weed control efficiency using imazethapyr @ 150 g/ha and increase the seed yield [14] of rice-fallow blackgram. Respectively, [65] post emergence as imazethapyr at 25 g/ha had no adverse effects on rain-fed blackgram. Among the herbicidal treatments [16], application of quizalofopethyl 50 g/ha increase in growth and yield attributes might be due to the reduction in weed competitiveness with the crop, which ultimately favored better environment for growth and development of crop.

Application of fenoxaprop-p-ethyl @ 75 g/ha or cyhalofop butyl @ 100 g/ha drastically reduced the density of grassy weeds in rice fallow blackgram [57]. Post emergence application of acifluorfen sodium + clodinafop propargyl at 300 and 240 g/ha sprayed at 15 DAS registered higher weed control efficiency (70.6 and 68.0 per cent, respectively) due to greater reduction in weed biomass in Blackgram [66].

Integrated weed management strategies

Now days, a various weed control methods were found to be effective in controlling weeds in blackgram and also its each other methods have their own merits and demerits based on resource available or environmental condition. However, efficient and cost-effective weed control can be achieved by using either combination of herbicides or combining herbicide alone or any one of the weed control method may not control the weeds effectively. In such condition, 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 favour 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 favour of crop [1].

Initial weed control through application of herbicide (pendimethalin @ 0.75 kg/ha) and further weed growth was drastically reduced by hand weeding at 40 DAS which situation to crop creating best growth condition [67, 68]. In the same way, combined effect of cultural (seed rate), mechanical (hand weeding at 40 DAS) and chemical methods (pendimethalin @ 0.75 kg/ha) markedly reduce the weed density and weed dry weight of Blackgram which led to increase the productivity and ultimately providing higher benefit cost ratio [69]. In general, sequence application of weed control methods like pre emergence herbicide prevent or kill the germinated weed seeds and further vigour weed growth was controlled by hand weeding for superior methods than individual application of other control methods of weeds [30]. Application of pre emergence herbicides as pendimethalin (1.00 kg/ha) or oxyfluorfen (0.18 kg/ha) followed by mechanical weeding (hand weed + intercultivation or two hand weeding at 20 and 40 DAS respectively) creating a better weed free situation and also provides economically safe to farmers [71]. Post-emergence herbicide as quizalofop-ethyl 50 g/ha at 30 DAS was significantly superior in reducing weed density both at 30 and 60 DAS while remained at par with the treatments of inter-culture 15 DAS *fb* imazethapyr 100 g/ha 30 DAS, interculture 15 DAS *fb* quizalofop-ethyl 50 g/ha at 30 DAS, and imazethapyr 100 g/ha 20 DAS [72]. Crop grown under line sowing with the application of quizalofop ethyl @ 50 g/ha recorded lowest weed dry weight followed by broad bed method and ridge method [48]. However, pre-mix application of imezathapyr + 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 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 [13].

Regulation of various weed control methods should be such that they give the competitive edge to crop over weeds. The integration of these methods with chemical measure is advisable to avoid the ill effects caused by the sole dependence on the herbicides. Some of the negative impacts of sole dependence on herbicides are evolution of herbicide resistance weed flora shift and soil and environmental pollution. Also, the continuous dependence on 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 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 focused attention of ecology and herbicides is adopted.

Conclusion

The above stated review results reveals 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 adopting 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 foreseeable future.

Author Contributions

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Conflict of Interest: None declared

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