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IWM on soybean- A review paper

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ABSTRACT

Soybean is known for its role in the human diet, however, is mostly ambushed by weeds and lose their productivity to about 79% or more. With IWM, providing a platform for several techniques and measures in order to control weeds. A review is carried out to understand the weeds found in soybean a field, IWM aims and its plans with help of secondary data.

Keywords: IWM, management, soybean, techniques, weeds.

I. INTRODUCTION

Glycine max (L.) Merrill, an annual legume, commonly known as soybean is an important oilseed as well a pulse crop of India. It acts as a fount of edible oil consisting of 40% protein, 20% cholesterol free oil and 23% carbohydrate and is known to play paramount role in human nutrition and in animal diet. In 2010 itself, it was reported that about 102 million hectares were harvested. Brazil, Argentina and US lead in covering total cultivated area more than 70%, along side India and China, these countries are reported about 90% of the total soybean production.

The crop production is directly related to growing demand for protein and oil for our daily diet and the viability of crop plays a huge hand in the manufacture of biodiesel, which is extremely vital for the global economy, usually grown during the *kharif* which causes tremendous weed competition and leads to serious outbreak. Among the several components that are responsible for lowering productivity of crop, weeds at early growth stage is one of the major factors which results in a loss up to of 79% or even more.

Chromolaena ordorata *Eclipta alba* *Cyperus iria* *Sida acuta*

Figure 1: Some common weeds in soybean

Insufficient weed control is one paramount nuisance that results to decrease in soybean production, as they tend to compete for light, water, space and nutrients with crops by resources. The critical period for crop- weed competition is during 15-45 DAS and this is found mainly in the initial stages of crop development, due to possible losses in production that can be up to 80% or even, in extreme cases. Weeds have traits of sheer aggressiveness even in diverse environmental conditions with ability to produce huge number of seeds, seed dormancy, effective dispersal ability, heterogeneity in population are just some of the vital characteristics which is often linked to their competitive nature, because rapid growth requires the prompt and efficient conversion of resources into biomass, thus, the yield is reduced and production costs increase, resulting in a decrease in farmer's income. Besides causing reduction in yield, weeds also degrade the quality of grain, causing loss and hindrance during harvesting period and serve as plant hosts of several diseases and pests; they can also release toxins that are harmful for crop growth and development.

Limiting weed competition is highly achievable with the wide range of techniques and tools (herbicides) that exist in the market, however, weed management methods are not solely related to the use of chemicals and herbicides. Weed management includes the suppressing of development/or decreasing the number of weeds in a particular site. The use of IWM eases weed management during all crop developmental phases. Cultural methods-proper fertilization, soil tillage, proper selection of cultivar, correct sowing time, monitoring the number of plants per area and crop rotation should be followed.

1.1 Weeds engage with plants for-

1. Water

Water is the most essential factor for plant growth and development. The soil moisture and rainfall intensity fully take part in influencing the growth of weeds, affecting, therefore crops growth and yield. According to Patterson and Flint, *Amaranthus hybridus*, which posses C4 metabolism, reported higher WUE compared to soybean plants. When soybean was compared to beans and some weed species like *Bidens pilosa, Desmodium tortuosum and Euphorbia heterophylla,* bean crop reported more WUE from the beginning of the cycle, however, soybean was the plant with the highest biomass accumulation rate and greater WUE along the cycle.

2. Light

It is the most debated factor in competition wise, highlighting the importance of plant height in defining the competitive ability of crops. Light interception by canopy is dependent on several factors- plant height plant density and arrangement, leaf area, branching rate, leaf angle, distribution of leaves, dry mass accumulation and angle of leaf blades and. Cultivars that concentrate photosynthates in leaves, *i.e.*, high leaf area ratio (LAR), have greater potential for ground cover and consequently the greater will be their competitive ability with weeds. Earlier emergence of weeds in soybean, in relation to crop emergence, increased grain yield losses of soybean. On evaluating, the utilization and efficiency of light by soybean and bean against the weeds *Bidens pilosa, Euphorbia heterophylla* and *Desmodium tortuosum*, it was reported that the highest accumulation rate of dry mass and the largest leaf area index for soybean, indicated its ability to capture light and shade the competing plants.

3. Nutrients

Major nutrients (NPK) are of vital importance for understanding yield losses by crops, the capacity to absorb nutrients in plants depends on morphology of the root system and its efficiency. Crops which possess fast root growth tend to increase WUE and nutrients so with advanced root system is desirable for better nutrient use. Under field conditions, in a study of competition for nutrients between soybean with the weeds, *Bidens pilosa*, *Euphorbia heterophylla*, *Bidens pilosa* and *Desmodium tortuosum* reported that with increase in leaf area also showed soybean produced the highest biomass in its root system, as with the doses of N, the N content among the leaves also increased.

II. IWM - INTEGRATED WEED MANAGEMENT

The plan for IWM in various weed species is classified as short or long-term. Methods like weeding or direct application of herbicides or weeding fall under short-term, considering for temporary management. In long-term methods, usage of cultural measures and managed by biological agents have permanent effect. IWM includes the integration of preventing and other managing methods which promote short (chemical and mechanical methods) and medium and long-term (biological and cultural ways) control.

2.1 IWM – THE REQUISITE STEPS FOR OUR FIELDS

Weeds are known for their notorious character and the aftermath on crops growth and yields, along with their hindrance in production practises. As we know, application of herbicide is one main form of weed management, however, over dependence on it has led to rise of herbicidal resistant weeds, with increase cases in US. IWM consists of several tactics and wide range of options to choose from including- alternation in herbicide tank mixtures, cleaning of equipments after usage, implementing more on crop rotations, altering in tillage practises, focusing more on cover cropping etc.

2.2 PRINCIPLES-

IWM concepts include-
(i) Reduce the density of emerging weeds among crops,
(ii)Decrease the relative competitive ability, and
(iii)Control the emerged weeds by applying non chemical methods, the above all objective of decreasing the usage and need chemical application in a cropping system. IWM favours the application of available weed management - fertilization, plant breeding, tillage practices, crop rotation, cover crops and planting pattern (mechanical, biological and chemically). To determine the proper weed control techniques, it is required to know the potentiality of the species, related to the specific crop, in competition for surviving with key components (water, light and nutrients) which are held responsible for reducing the crop yield.

Chauhan *(2012*) observed that single method of weed management cannot provide potent weed control.

2.3 INITIATION OF AN IWM PLAN

It would be of great ease to recommend a specific IWM plan to fit all crops, however this is not practical. Every field, ought to be monitored to determine the most economical and efficient weed management package. Farmers have to look and plan programmes practically, plans can be altered with introduction of new technologies. The goal is to create an effective weed control programme that would not depend solely on single herbicide for successive years and risk of weed shifts and herbicide resistant weeds can be reduced.

1. Purpose: Farmer ought to frame the purpose of the plan and the extent to achieve it, which requires creation of short and long term goals for the farm's IWM programme.
2. Weed management areas: The areas ought to be revised in terms of boundaries of each area to be managed. A managed area may depend from a portion of one site to a group of areas or fields that consists of similar weeds, the area information should consist list of general topography; soil types; potential impact from adjacent vegetation; vegetation cover.
3. Problem weeds: Farmer has to identify the problem weeds for each of the area. This includes listing for each field, identify three to five key target weeds and sketch maps to show the location of known weed infestations in the field. Aid can be taken from the internet. Farmers ought to be aware of the alterations and be updated with the present weed problems.
4. Effectiveness of control measures: Prior to planning the next step, farmer has to monitor, each area of management, the effect of prior control and to note down any hint in regard to weeds being herbicide resistant. It is an effective way to monitor the history of the area.
5. Planned crop rotations: Looking forward, the farmer should list the potential crop rotations planned for each field and note any potential volunteer issues that might arise for each crop rotation.
6. Control tactics: It is important to make a list of feasible weed control strategies and ways that are applicable for each field. The list should have effective method against the target weeds for the field and limitations or risks that apply for each control method.
7. Management plans: with the data gathered, farmer should be ready to prepare a management plan for each area by monitoring the most applicable control method for each area with careful consideration about effect, cost, feasible for applying with available resources
8. Application: A well organised, researched and reviewed plan would make the farmer is ready to apply weed management for his area. Precise records are important to be able to see the effect. If the data shows that the plan needs to be altered, they have to be applied quickly.
9. Revision and analysis: Before implementing the plans, the farmer should know the benefits.
10. Impact of keeping precise data: Data keeping is vital and essential for controlling crop of herbicide tolerant. In absence of such, silly errors are made and prove difficult to evaluating herbicide tolerant crops. Records should be maintained on:

- Lists of nuisance weeds in their prevailing areas,
- History of cropping systems,
- Control tactics based on available resources,
- Weed management implementation plans,
- Proper monitoring plans.

2.4 TOOLS OF IWM

1. Prevention: This is vital but often ignored at times; usually the foremost in line and considered chief step for dispersal and spreading of weeds (water, wildlife or wind). Proper steps should be taken - efficient seed material, machineries and tools etc. In short, human are the key factor in preventing further control, selecting the proper variety is basically the first in establishment of a crop. Chauhan *et al.,(2012) concluded* that several crops tend have pure seeds mixed with weeds seeds, mostly as they have similar seeds shape and size, this mostly occurs when weed seeds have similar growth cycles with the main crop. Even little amount of weed seeds present may be viable till the following season.

2. Monitoring: This is a vital component of IWM and with regular monitoring of weeds help farmers in following crop rotations and weed control techniques. Collection of info on weed species is helpful in making decisions about crop losses. These files and data records provide records on evaluating the effect of weed control programmes and aids in making decision.

3. Chemically measures: There are various benefits with herbicides: destroying the weeds ahead; targeting the areas where implements do not hit; eliminating the risks of harming the young plants and roots; not altering soil surface and, hence eliminates erosion; reducing labour charges and increasing rate and efficiency of the control, the drawback is it affects the environment, crop and the farmer. Even though are very helpful in eradicating weeds, they also assist in resistant biotypes. According to Oliveira Jr. *et al.*,(2006) mentioned that the usual tactics used in control of both cover crops and weed in areas are reduced to three: drying before sowing, between seven and ten days prior to sowing. A study was aimed to assess the interactive between weed control and tillage systems in post emergence in soybean; it was concluded that, with drying in different systems have been effective, the suspense of desiccation in anticipated management favoured the emergence and initial soybean development, providing greater productivity gains, given the infestation conditions. Arregui *et al*.,(2006) reported that several soil-applied herbicides that control- *Ipomoea spp., Commelina spp.* and *Sida spinosa*.; *S. spinosa* density reduced with sulfentrazone, imazaquin and metribuzin on applying cloransulam and diclosulam; Chlorimuron and sulfentrazone decreased Ipomoea spp. density. Commonly used herbicides for controlling weeds in soybean are glyphosate, imazaquin atrazine, trifluralin, Imazethapyr and Imazamox.

4. Biological steps-

The use of natural rivals like virus, birds, fungi, bacteria, viruses, insects etc. capable of destroying weed sp which is done by balancing between the host and its natural nemesis with objective to allow weeds with their enemies in achieving feasible weed management. These natural nemesi are known as biological control agents, include plant pathogens as they hamper with the gene mechanisms and plant growth processes will provide control to weeds. It is crucial and important to test them before their release as to make sure they do not pose threat to other living species. They are usually costly and require good amount of investment and long term period of work. During the 1920's,a successful weed control was done in Australia to control Prickly pear weed which used to spread rapidly, *Cactoblastis cactorum(*Cactoblastis Moth) was introduced to control the vicious weed. There are several successful stories of biological control, where the insects were used to attack the stems, leaves and over all control of weeds. https://www.environment.gov.au/biodiversity/invasive/weeds/management/biological-control.html . Bioherbicies are the use of plant pathogens for weed control through multiple application of their inoculums, widely used in several countires and US. On current scenario, a fungus sp. is known to be registered under bio-herbicide in the US for soybean crop; based on

Colletotrichum gloeosporioides f.sp. *aeschynomene* for collego bio-herbicide (Charudattan & Dinoor 2000)

5. Mechanical steps

Hand wedding or plucking is the most ancient form of weed control and still prevail at home done manually or with hoe or space (Silva *et al*.,2007). One efficient way is use of hoe which is quite cost efficient and widely common among farmers, but it requires intense work in large fields or areas with more need of manpower and searching for labour is quite hard. It is usually advised to remove the weeds when they are young before heavy infestation which affects the crops and soil at the same time. Mechanisation is carried through tractors or animals, widely practised in Brazil as it a chief way to control weeds, but one major limitation is struggling in small spaced rows and produce low efficient results when performed in wet land. Based on the crop and weed species, proper implements- hoe or cultivators can be applied to initiate weed control even on closed rows or spaces.

6. Cultural steps

Methods like improving crop competitiveness, crop rotations, burning, tillage and mowing can be effectively followed for weed control and practised in an IWM programme.

a. Stale seedbed

This technique that gives crop an upper edge, false seed bed is made to allow the flush to seeds to grow prior to be sowing of the main crop and weeds are removed which tend to appear at time of germination and then controlled by non selective herbicides (glyphosate or paraquat).

b. Crop rotations and alteration in row spacing

Various weed species thrive best in certain cropping patterns, soil and sowing dates. For example- perennial weeds often link with perennial crops, while annual weeds relate with annual crops. Monoculture usually results to heavy infestation of weeds when the field is kept barren, however, in crop rotation it destroys the weed populations and hampers with germination and with the alteration of crops along with sowing dates and tillage practises, it serves as a threat for the weeds and creates more competition at the same time, causing it a severe problem for the weeds. Change in crop rows and growing different crops can help in monitoring weed population, control weed shifts and while using various kinds of herbicides it reduces risk of herbicide resistant.

The main aim in alteration of row spacing is to cover the crop area with high seed rate and narrow row spacing as fast as possible, which gives more competition for weeds and leads to heavy suppression by the crop canopy.

c. Optimum sowing time and seed rate :

Weeds require different light, temperature and moisture for their growth, like *Amaranthus* sp. and foxtail *Setaria sp*. germinate under temperate conditions unlike *Sinapis arvensis* & *Avena fatua* in chilled soils tend to germinate early. Knowing this, farmers can be benefitted and rotate crops at different time periods. Under dry conditions, seed rates can be increased that would allow inter plant competition and may reduce yields. For productive control, covering of weeds by crops through canopy cover may be most efficient and ideal idea for competition with weeds (Harker *et al*., 2003).

d. Surface seeding

This promotes rapid germination ability, with better competition for weeds, like broadcasting, hand seeding, seed planter, drill seeding etc which allows precise placement of the seeds

e. Nutrition

Weeds and crops tend to compete most for nutrients (NPK) and reports and studies have proven that with addition of nutrients and supplements they turn to be sufficient for crops.

f. Intercrop & cover crops

Intercropping is a way crops can smother the weeds and prove to be a great strategy to follow and advantage for the farmers. Cover crops tend to hamper with the germination of weed seeds as they also compete for various factors (Kruidhof *et al*., 2009; Clark, 2007; Kruidhof *et al*., 2008).

g. Tillage

There are various benefits and defects for using tillage for weed control. If carried out ,it is an efficient and effective form to decrease weed community but when soil is exposed it may lead to depletion of nutrients, erosion or destroy soil property.

III. CONCLUSIONS

IWM study has monitored how weeds affect the crop growth and their influence on productivity in fields. With change in farming practises such as- herbicidal rate and application timing, implementing cover crops, cropping patterns and rotational measures, there will higher acceptance of IWM guided with right strategies would lead to less reliance on herbicides. It is required for integrated weed management to move from a vivid picture to reality stage in the present generation.

Abbreviations

IWM : Integrated weed Management

FB : followed by

Et al : et alia

Sp. : Species

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