



Relevance of weed science in modern agriculture

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ABSTRACT

Weed science is the one of the discipline in agricultural sciences which mainly concerns with plants that may be considered weeds, their effects on human activities, and management. Weed science unlike entomology and pathology is very recent discipline of agriculture considered important in 20th century and since then attention is being paid to evolve weed control technologies for higher crop production under safe environment. The role of weed management under changing modern agricultural scenario has become more important considering the higher labour wages as well as non availability of labour at peak time of availability. The research on use of herbicides continued since 1960 and between 1980 and 1990 many herbicides having lower doses of application compare to earlier herbicides and also herbicide resistant crop came into existence. Herbicides residues in soil and plant are also of great concern considering health and environmental hazards. Continued application of same herbicides in same field invite resistant biotype which are difficult to control. Hence, development of eco friendly technology is the call of day. There is need to go strengthen weed science research under changing agricultural scenario under climate change, conservation agriculture, precision farming, herbicide resistance weeds, integrated weed management, weed management in pulses and oilseed crops, use of un manned aerial vehicle, plant image science for weed control to mitigate the challenges of modern agriculture.

Keywords: Herbicide resistance, integrated weed, precision farming, weed science

India is considered as mega biodiversity because of large number of vegetation, flora and fauna are found and ranks sixth among global biodiversity as it includes more than 40,000 species of plants. They cause considerable difficulties to the farmers by interfering with agricultural operations and increasing labour requirement. Naturally, ways and means to manage the weeds in both crops and non crop situation also emerged. In mans effort to provide favourable environment for growing his specialized crop plants, he first encountered weeds, plants that thwarted these efforts. India is called as mega biodiversity because of large number of vegetation, flora and fauna are found and ranks sixth among global biodiversity. Since inception of agriculture, man has confronted with some undesirable type of plants which later termed as weeds. Weeds are defined as plants – “out of place “ , unwanted, non useful, often prolific, and persistent, competitive, harmful, even poisonous, - that are known as weeds that interfere with agricultural operations, increase labour, add to cost, reduce yields, and distract from comforts of life. Weeds have been a matter of concern since man started cultivation as it has been a serious problem in crop production from the day human started growing crop. They reduce crop yield by competing for water, light, soil nutrients, and space. Jethro Tull (1674 - 1741) was of the view that weeds could exploit the gaps and compete for moisture and nutrients.

According to Global Compendium of Weeds there are altogether 28,000 plants identified as weed species.

Among these plants, nearly 8000 weed species belong to agricultural weeds spread all over 124 countries and 250 weed species are considered to be problematic. Further, Of the 300 plant families it is reported that 75 families comprise 75% of all flowering plants and of these only 12 families constitute 68% of the worlds worth weeds. Within these 12 families, just 3 families viz . poaceae, asteraceae and cyperaceae comprise 44% being worst weed grouped in India.

Losses by weeds: Losses caused by weeds in Indian agriculture are estimated to be 33% as compared to 26% by insects, 20% by disease and 21% by other biotic factors. This yield loss is due to stiff competition offered by weeds to crops in terms of nutrients, moisture, space light, CO₂, other a - biotic and biotic factors. The critical crop weed competition is usually initial 1/3 period of crop duration i.e. first 40 days for a crop of 120 days duration. Weeds posses' inherent hardiness, prolific seed production, vegetative reproduction, seed dormancy, seed longevity by means of which they survive for long period and escape control. Thus weeds are disputable subject and for farmers, they are the plants which need to be controlled in order to get satisfactory food, fiber, feed for human and animal consumption. Thus weeds negatively affect human living indirectly. Weed science is the discipline concerned with plants that are considered weeds, their effects on human activities, and also their management (Monaco, et al, 2002) . According to Zimdahl, and Robert, 2013" Weed science might be

considered a branch of applied ecology that attempts to modify the environment against natural evolutionary trends.” With the upsurge of interest in weeds, people from other disciplines are turning to this group of plants in their studies, and in the journals we find papers by ecologists, plant pathologists, and taxonomists as well as those by agronomists and general agriculturists. And so there is developing new disciplines that are attracting more and more interests and that offers promise of becoming a major field of biological research and activity.

The very basic purpose of weed science is study to control or manage weeds in crops and cropping system to harvest a profitable return. The weeds can be considered as an enemy to crops who share large quantum of natural resources leaving crop plants in stress. Thus, to combat the weed problem one has to be equipped with all sort of knowledge about what weeds possess that make them more competitive than crop. Weed Science is the study of management of vegetation in crop production, horticulture, non crop area or any place where plants need to be managed.

It involves all sort of methods like cropping systems, herbicides and their management techniques and development of weed competitive varieties. For exhaustive and complete knowledge of weeds it requires study of plant ecology, physiology, and the genetics of plants species that have been identified to influence on the economy and our ecology. Weed science also involves biological, taxonomical study of weeds as well as knowledge of major mechanisms of their survival for developing effective methods of weed management.

The need to revisit weed science in changing agricultural scenario: The role of weed management under changing modern agricultural scenario has become more important considering the higher labour wages as well as non availability of labour at peak time of availability. The conventional method of weed control like weed pulling or hand weeding is becoming very difficult. Many a times a potential crop faces failure owing to weed management problem. Invention of chemical method of weed control in 1940s were in the form of application of salt, iron sulfate, sulfuric acid, and copper sulfate (Klingman and Ashton, 1975). Between 1940 and 1950 a good number of herbicides were discovered and by 1950, about 25 herbicides were available for use (Timmons, 2005). Thus by 1960s chemical method of weed control anchored its feet and weed science as a discipline found its place similar to entomology and plant pathology in agricultural sciences. The research on use of herbicides continued and between 1980 and 1990 many herbicides having lower doses of application compare to earlier herbicides and also herbicide resistant crop came into existence.

Emerging issues in weed science: The green revolution in India brought a revolutionized country's production system owing to high levels of nutrients and use high yielding crop varieties under intensive agriculture. Latter on its impact on soil health and associated problems brought serious concern to revisit the issues.

With increasing awareness about harmful effects of herbicides residues on human health and environment and the evolution of herbicide biotypes, focus within weed science effort has to be made for development of eco friendly technology with reduced reliance on herbicides. Moreover, development of herbicide resistant varieties of crops and use of herbicides in accordance to climate change has made the weed science further multifaceted and multidisciplinary. The course curricula of weed science is more or less in all over the country. The need to stress the regional issues of weed management is overlooked. There is need to incorporate more research under following heads to mitigate the changing agricultural scenario of country:

1. Climate change: The climate change in recent years has further aggravated weed problems. Weeds because of their peculiar biological characteristics of hardier are better adaptive under wide range of climate change than crops. Vagaries of monsoon have shifted the sowing and transplant of rice crops. The weed flora under delayed sowing and transplant of rice is changing. Change in optimum time of sowing or transplanting owing to change in monsoon pattern affects crop performance, however, weeds remain unaffected due to diverse gene pool and plasticity. Hence, management of late transplanted rice or replacement of transplanted rice with direct seeded rice is the call of the day. Similarly to catch the appropriate sowing time owing to vagaries of weather, transplant technology of other crop plants like pigeon pea or mustard is also a researchable issue. Response of C3 and C4 plants behave differently. The C4 crop plants are maize, sorghum and millets while there are many C4 types of weeds. Most of the plants are C3 types which will get added advantage of increasing carbon dioxide in atmosphere. The efficacies of many herbicides under changing environmental condition make weed management more complicated to achieve sustainable crop production. Thus study of herbicide efficacy under changing environmental condition is an important aspect.

2. Conservation Agriculture: In many parts of India the conservation agriculture is becoming popular among farmers owing to its lower cost of cultivation, timely adjustment of crop under cropping system. It also improves soil health due to retention of crop residues thus bring out sustainable crop production. Conservation

agriculture is directly related with tillage as conventional tillage, minimum tillage, reduced tillage and zero tillage has their own advantages and disadvantages. Under conventional tillage inversion of soil as well as many trips of cultivator to bring soil friable, give chance to underground buried weed seeds to come up on the surface thus new complex weed flora starts appearing. While under minimum, reduced or zero tillage, majority of the seasonal weed seeds which remain on the top 4-5 centimeters, germinate simultaneously with crop seeds making competitive edge over crop seeds. Use of herbicides under this situation is essential. Prolong use of herbicides under such situation may bring other associated problems of development of resistant weeds, soil fertility and herbicide residues. Thus alternative weed management strategies like integrated weed management, soil solarization, stale bed methods, crop rotation by selection of competitive crop, crop residues retention (type and quantity of crop residues), crop rotation, intercropping sowing technology suitable to small and marginal farmers, are the major researchable issues. The role of weed science under these situations is very pertinent. The dynamics of different weed flora, their biology and control methods need further investigation.

3. Precision Farming: The precision farming *i.e.* site specific weed control in crops is new avenues for research in order to use need based herbicides. The patchy population of weeds makes weed control difficult. If we observe the entire field or farm area from height say airplane, we will find that entire field is green and weed species cannot be differentiated, however when we see from ground level the different weed species are growing in patches or in cluster. This makes unsatisfactory weed control. The cause of patchy weed population can be because of differential germination time, dispersal, soil type, fertility gradient and aggregation of freshly formed weed seeds near their parent plants. The technique of site specific weed management is not to have uniform weed population but this will be helpful in selective weed management in order to reduce herbicide application.

1. Herbicide resistance weeds: enhanced labour wages and easy way of weed control, the use of herbicides is gaining popularity among farmers. Continuous use of same herbicides in the same field has is developing new problem of development of herbicide resistance biotypes of weeds. It has been reported that out of total 270 globally, have only 17 mode of action and among them only three mode of action *i.e.* aceto lactate synthase (ALS), Photo system II (PSII) and protox inhibitors are predominant (Macías *et al.* 2007). Thus

lack of new herbicides with different MOA has deterred the weed control in crops. Hence there are researchable issues for testing more and more herbicides with different mode of action on crops. Study of genetical, physiological, morphological features of weeds adaptive to different ecological situation will suggest to design the ways integrated weed management (IWM). Repeated use of herbicide resistant (GR) varieties giving birth to super weeds which are not controlled even by glyphosate. In countries imidazolinone resistant varieties of rice posing problem of weedy rice which is global Another issue related to herbicide resistant crops are that they may transmit their pollen to their wild types which may evolve a herbicide resistant biotype weed. Therefore a cautious effort in this direction is also a matter of concern.

2. Integrated weed Management: Over reliance on use of herbicides has side tracked integrated weed management. According to a study, (Harker, 2013) reported that since 1996 to 2012 more publications had been for chemical weed control and less for IWM. Under IWM, the option for cultural manipulation by adopting appropriate crop rotation, tillage, selection of competitive crop/varieties, soil solarization, stale bed are the avenues by which over reliance on herbicides can be minimized.

3. Weed management in pulses and oilseed crops: The pulse and oilseed crops are badly sufferers of use of herbicides. Information on use of herbicides with variable mode of action for these crops are meager. Many journal come out with the information that hand weeding is the only option.

4. Use of un manned aerial vehicle: Use of UAV, in which “drones” are used, is the new technology which can influence pace of weed science research in days to come. The UAV provides data of high resolution to the scientists which can transform agricultural research. However, it needs a approval of policy at government level to use UVA for research purpose.

4. Plant image science for weed control: With the advancement of information technology, plant images are also being used as tool to utilize images to acquire, process and analyse plant images for plant research. The biotic and abiotic stresses of plants responses are being sensed by remarkable development of plant image science which is a branch of science which utilizes image science comprising technique and processing for plant research. The plant images can be used to find out the herbicidal activity much earlier than conventional method as plant images contain biologically meaning full information. In conventional methods not only substantial amounts of time is required but they are also

and involve herbicide study and development very expensive and time consuming. In plant image science plant spectral images are used to identify weeds and to diagnose herbicide resistant weeds more rapidly and accurately. The weeds are identified with the help of RGB camera

Considering important role there is need to revisit weed science research under changing agricultural scenario of climate change, conservation agriculture, precision farming, herbicide resistance weeds, integrated weed management, weed management in pulses and oilseed crops, use of un manned aerial vehicle, plant image science for weed control to mitigate the challenges of modern agriculture.

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