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AN ANALYSIS REGARDING SEVERAL ASPECTS OF WEEDS

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ABSTRACT

Weed issues are expected to grow and become more complicated in contemporary agriculture, as greater focus is placed on high input systems. With increased knowledge of the negative effects of herbicide residues on human health and the evolution of herbicide-resistant weed biotypes, weed research has turned its emphasis to the development of eco-friendly technologies that rely less on herbicides. Furthermore, with the widespread use of herbicide-resistant crops and the uncertainty of climatic optima as a result of climate change, weed science issues have multiplied. To deal with these complex weed issues, a multi-disciplinary strategy is needed, which includes changes to technology, managerial methods, and laws. For creating sustainable weed management methods, more understanding of weed ecology, biology, genetics, and molecular biology is required. Furthermore, judicious use of sophisticated technology, such as site-specific weed management systems and decision support models, will play a key role in lowering weed control costs. In addition, better connections between farmers and weed researchers will be required to promote the adoption of technology advances. To address these difficulties, research objectives must be established, and the weed science education system must be reoriented. Closer cooperation between weed scientists and other disciplines, in particular, may aid in identifying and addressing the complex weed management problems of the twenty-first century. This agreement will allow for more flexible and diversified approaches to creative teaching and training methods, which will be required to educate future weed science graduates to handle the expected weed science problems in modern agriculture. Additional funding for both weed research and weed management education is required to develop this capability.

KEYWORDS: *Agriculture, Crop, Herbicides, Science, Weed.*

1. INTRODUCTION

Weeds are a continuous issue in agricultural productivity because of their dynamic and tenacious character. The extent of weed infestation in the field is determined by agronomic practices (such as crop type and cultivar competitiveness, crop rotation, type of tillage, fertilization method and timing, row spacing, seeding densities, and herbicides), soil type and fertility status, and prevailing environmental conditions. Weeds are botanical pests that share the same trophic level as crop plants, resulting in significant agricultural production losses due to weed-crop competition for light, water, and nutrients. In order to decrease weed densities in future years, a good weed management program usually combines two goals: limit yield loss due to weed competition in the near term, and avoid adding weed seed/vegetative propagules to the soil seed bank. The introduction of a wide range of herbicide compounds for selective weed control has transformed modern agriculture, which has become more productivity-oriented than ever before. The use of herbicides for weed control in agricultural crops has simplified and reduced the cost of production, allowing farmers to expand their operations. However, with the increasing availability of selective herbicides for weed control, ecologically sustainable weed management as a component of agricultural systems seems to be overlooked. Although herbicide-based agricultural methods have helped farmers in many ways, continued usage and excessive dependence on herbicides has resulted in the development of herbicide-resistant weeds, changes in weed flora, and pollution of the environment, mostly via water movement **[1].**

As a result, there is a growing agreement that designing weed control methods with less dependence on herbicides is critical to overcoming the negative consequences of overuse of herbicides. As a result, weed scientists confront a challenge in developing creative, environmentally sound, cost-effective, and long-term weed control methods that can be incorporated into current and future cropping systems to provide a more varied approach to weed management. Weed control strategies are now considered a continuous activity within agricultural systems due to the genetic variety and developmental flexibility of weed populations. Herbicide-resistant biotypes, invasive plant species, and climate change have all forced weed scientists to create cutting-edge technology. Weeds' multi-faceted nature will continue to offer multi-dimensional difficulties for researchers, and the hunt for novel answers to these problems may once again transform agriculture **[2].**

Another complicating issue in this crucial activity is that the objectives and directions of weed research, which were formerly well-defined and generally accepted, seem to have shifted in recent years. Several academics have questioned whether weed science is progressing in the correct way, and if it has been able to have a practical effect on present emerging issues as a consequence. Indeed, several writers have stated that the contribution of weed biology and ecology research to sustainable weed control programs is inadequate, and that more systematic and focused effort is required. Similarly, a subsequent research found that, even in the chemical era, weed biology knowledge seems to be essential and may serve as the foundation for effective weed control. In this respect, a variety of methods that may link weed biology research to practical weed control are required. Cousens stated that, although weed threshold values are an essential part of weed science research, they are seldom used in practice. The author blasted a slew of phenomenological research and an over-reliance on replicating repeated case studies, claiming that they had turned marijuana science into weed technology. The findings echoed Wyse's call for a better understanding of the fundamental concepts underlying marijuana science, as well as a paradigm change in key research topics, shifting from recording "what happens" to "why things happen." Ward et al. highlighted two main elements for development of the weed science field in their criticism of agricultural weed research: scientific investigations must be reoriented toward a knowledge of weed biology, and management initiatives to reduce the harmful effect of herbicides. These writers critiqued current weed research as being repetitious, with an overabundance of merely descriptive studies that fail to connect new hypotheses to known ecological and evolutionary data. The authors argued that agricultural weed research should be revisited in a more holistic way, with a wider perspective, a deeper theoretical rationale, and an inter-disciplinary approach **[3].**

It has been suggested that the field of crop protection, which includes weed science research, should shift from technology-oriented to system-oriented strategies, which recognize innovation as a perfect blend of technological and non-technological (institutional and social) advancements at multiple levels, ranging from the field to the farm and the region. In this regard, a thorough introspective examination of decided objectives, available resources, orientations, progress assessment, and distribution of findings to the target audience are important concerns for weed science in the near future, so that the field emerges stronger and more focused. We intend to highlight and prioritize current issues in weed science research and education, identify challenges and issues, and critically assess what can be done to push the frontiers of weed science research and embrace horizons of quality oriented weed science education in a positive and constructive manner here. We want to stress that the material in this post is intentionally broad and not customized to a certain climate or nation **[4].**

1.1 Emerging Issues in Weed Science:

1.1.1 Herbicide Resistance and Weed Plasticity:

Herbicide-resistant weeds have evolved as a result of an over-reliance on herbicides as the primary instrument for weed management, as well as the continued use of herbicides with similar modes of action (MOA). Herbicide-resistant species such as the Amaranthus complex in maize and soybeans, as well as grass weeds in cereals and cereal-based rotations, have severely restricted herbicide choices. Another notable example is the development of glyphosate resistance in Sorghum halepense, as well as the spread of resistant biotypes through seeds and rhizomes, first in Argentina and later in the United States. In reality, just 17 MOA are covered by 270 herbicides on the worldwide market, with almost half of them acting as acetolactate synthase (ALS), photosystem (PS) II, and Protox inhibitors. Weed management has been hampered by the lack of new/novel herbicide MOA development in the past 20 years, which has resulted in herbicide resistance. Since the mid-1990s, the broad adoption of glyphosate-resistant crops and the extensive use of a single herbicide (glyphosate) for weed management has slowed the search for a new herbicide MOA. From 11 in 1995 to only 1 in 2002, the number of active chemicals utilized in at least 10% of the soybean area in the United States has dropped significantly. Old herbicides are occasionally deregistered for unscientific reasons, reducing the variety of chemicals accessible for weed control and increasing dependence on fewer active components, resulting in greater selection pressure. The most common causes for de-registration include loss of effectiveness owing to increasing resistance by the target weed species, and undesirable environmental impacts due to high persistence, leaching characteristics, or endocrine disruption in animal species. Due to the loss of existing herbicides and the absence of new herbicide molecules, general weed issues in specialty crops/vegetables are on the rise **[5].**

1.1.2 Gene Flow from Herbicide-Resistant Crops:

Crop-related weed species are already a problem in herbicide-resistant crops in places like the United States, where these crops have been used for a long period. These species, on the other hand, are becoming a problem in nations that are increasingly embracing herbicide-resistant crops, such as Malaysia. Weedy/red rice in direct-seeded rice, Aegilops cylindrical and Elytrigia ripens in wheat, cruciferous weeds in rapeseed, Helianthus annuus in sunflower crop, Sorghum halepense and Sorghum bicolor (shatter cane) in sorghum are some examples of these species. Weedy rice has now become a significant problem in rice production systems all over the world. Because of the development of imidazolinone-resistant weedy rice, the introduction of imidazolinone-tolerant rice has resulted in a massive weedy rice infestation. A significant issue is the possibility of gene transfer from herbicide-resistant crops to wild/weedy cousins through pollen. In the United States, for example, weedy rice has developed resistance to herbicides used in herbicide-resistant rice. Herbicide-resistant volunteer crops in rotation with cross-pollinated crops, such as corn with soybeans and oilseed rape/canola with sugar beets, may enhance the likelihood of gene flow even more. The number of scholarly publications condemning the dangers of gene flow from transgenic crops to wild weedy cousins significantly outnumbers those describing "how to cope with this problem.

1.2 Misconceptions about Integrated Weed Management and Neglected Areas of Research in Weed Science:

The idea of IWM has been misunderstood, and the method has not been implemented in its entirety. Rather of depending only on herbicides, the implementation of true IWM programs requires more efficient and varied methods (e.g., sequential application and tank mixtures). Herbicide research is now increasingly focused on weed research, and more funding is being given in this area. Several opponents have claimed that weed science is more of a study of pesticides than of weeds. The scientists looked at weed research papers from 1995 to 2012 and discovered that there were more publications on chemical control than an integrated strategy. The United States had the most weed scientific papers of any country. Switzerland, the Netherlands, New Zealand, Australia, and Canada have generated a disproportionately high number of publications on IWM when compared to their population sizes. Rather of depending on a single weed management technique, IWM emphasizes variety of weed control strategies. In its purest form, IWM entails lowering the selection pressure for the development of resistance to any one weed management technique. Tillage, sowing time, planting pattern, cover crops, row spacing, fertilizer, and water management are examples of cultural manipulations in IWM that may supplement and replace herbicides by providing "many tiny hammers" on weeds. Advanced understanding of weed ecology and biology is required for successful IWM techniques. Weed biology and ecology (knowledge of weed species and their roles in agro-ecosystems) has been neglected for a long time, particularly in developing nations, due to the effectiveness of chemical weed management. Weed seed dormancy is an essential issue for IWM programs, as it has consequences for seed bank dynamics and periodicity. However, owing to the complex nature of functional connections between biological processes and environmental factors, predicting it remains a difficult job. This problem has had an impact on the overall forecast of weed emergence extent and time in agricultural settings. Herbicide resistance has been linked to increased seed dormancy and delayed germination. Glyphosate resistance and temperature-mediated seed dormancy in certain glyphosate-resistant populations were recently found to represent coselection of resistance and avoidance enforced by decades of intense cropping techniques, according to a recent research. In oilseeds and pulses, true IWM alternatives are few. The majority of the study papers recommended IWM with manual weeding for these crops **[6].**

1.3 Herbicide Related Contamination:

Herbicide residues in crops, soil, and ground water pollution are causing increasing concern. Herbicides are known to interfere with soil enzymatic and microbiological activities, which are necessary for many of the reactions and transformations that regulate soil health. The effect of herbicide treatment on soil function was recently investigated. The authors speculated that herbicide use may have a substantial impact on soil function, citing changes in earthworm ecology in soils exposed to glyphosate and atrazine, as well as site-specific increases in disease caused by a range of herbicides. At approved or slightly higher application rates, sulfonylurea herbicides may influence N-fixation, mineralization, and nitrification, according to the authors **[7].**

1.4 Opportunities:

1.4.1 New Avenues of Weed Science Research:

Weed surveying and mapping methods must be updated in order to comprehend changes in the geographic distribution of weed species. For each area, weed prediction maps and decision-making tools should be created. Weed scientists and crop consultants should be taught about drones so that they may utilize this technology to create decision-making tools. Remote sensing technologies allow for the development of fast and accurate scouting and prescription maps, allowing for better weed management choices and environmental protection via the use of more site-specific control methods (hand-weeding, targeted tillage, or spot spray). Advanced optical-sensor-based sprayer technology for site-specific herbicide treatments is still in its infancy. Similar to the present practice of broadcast herbicide treatments, hyperspectral imaging to distinguish between crops and weed biotypes is a relatively new idea. It would be a step ahead in attaining precision weed control objectives by administering herbicides just where they are required. To decrease herbicide load and limit herbicide runoff in furrow-irrigated cropping systems, further study is required on alternative precision herbicide application methods, such as the use of shielded sprayers or herbicide bands. It's also possible to look into the use of nanoherbicides and field robots for precision weed control. For example, an Australian university has created a completely autonomous weed-killing robot that it claims would reduce weed management costs by 90% and save the agricultural industry $1.3 billion per year. Its capabilities include scouting, weed removal, spot spraying, and the precise delivery of pesticides and fertilizers **[8].**

1.4.2 Implementation of Need-Based Weed Research:

As part of precision weed management, it is necessary to determine weed threshold values in key crops so that weed control techniques can become sustainable even with lower pesticide loads. Precision weed control technologies may help mitigate herbicide-resistant weeds by enabling site-specific weed management and weed seed prevention from survivors, reaching zero seed thresholds, and therefore helping to optimize the use of herbicides. In order to develop long-term weed management methods, modelling research on crop-weed competition should be investigated **[9]**. Long-term research in weed science are unavoidable, particularly in weed ecology, weed resistance evolution, and herbicide-resistant crops. As a result, private businesses should contribute to the financing of student and young scientist initiatives. Diverse weed management methods are required for long-term weed control, according to our findings. To reduce the usage of pesticides, IWM, such as cover crops, tillage, row spacing, and crop density, should be investigated for long-term weed control in various crops. At the same time, weed science research must be geared toward farmers' requirements and incorporate their input in order to offer cost-effective weed-control solutions while also safeguarding future generations via a commitment to genuinely and long-term weed-control methods. Farmers' involvement in weed science research has to be increased on a practical level in order to guarantee the development of practical and sound decision-making tools **[10].**

2. DISCUSSION

Exotic weed proliferation is now well-known as a consequence of increasing global commerce, possibly generating worrisome new scenarios in the wake of climate change. As a result, sophisticated weed science expertise will be needed to develop new methods for dealing with such complicated developing weed management issues in the twenty-first century. Weed scientists will need to rethink the idea and methods of IWM as a direct result of this situation, since its non-chemical components are presently being given less importance by both public research institutions and the agricultural community, with continuing dependence on synthetic pesticides. We believe that new and varied teaching methods should be created to better educate weed science graduates for the difficulties that the future of agriculture will bring. Weed science research, education, and extension now fall behind the priority requirements of weed management in natural, agricultural, and urban environments, and this condition is anticipated to deteriorate as climate change takes hold. In this respect, more resource mobilization and financing may be helpful. The number of jobs dedicated to weed science research, teaching, and extension should be expanded, particularly in regions where there are severe shortages (such as natural ecosystems and non-cropland weeds, and invasive plant management). Weed science should be pushed to be a significant department of all agricultural institutions, providing new graduate and post-graduate degree programs, in the same manner that other plant protection fields (plant pathology and agricultural entomology).

3. CONCLUSION

Weed science integrates fundamental and applied sciences to better understand and control weeds as an applied and integrative scientific field. Weed control that is done correctly ensures food security by increasing productivity and profitability while also protecting the natural resource base. One method for increasing production and closing yield gaps is to successfully identify and eliminate weed threats. Weed scientists have a difficult task in dealing with a slew of issues that, although important, go unexplored. Plant physiologists, molecular biologists, and invasion ecologists are currently tackling complex vegetation management issues and challenges that require weed scientists to look beyond the herbicide efficacy/fate box and investigate basic and applied research pertaining to complex vegetation management in both natural and managed ecosystems. Site-specific weed management systems, herbicide-resistant transgenic crops, drones to monitor weed population dynamics, omics, novel herbicides, molecular biology tools, Nano herbicides, and simulation and decision support modelling have all been developed in recent decades to overcome various technical challenges. The human component is more difficult to address, and weed scientists must deal with problems such as farmers' inability to recognize the magnitude of the weed threat, particularly when the harm and losses are not immediately evident. The evaluation of the environmental effect of weed control methods has emerged as a new and important field of weed science study. Advancements in engineering and computer sciences, along with precision identification and application modules, may assist rapidly identify and manage weeds in the context of precision agriculture. Weed research will need more worldwide cooperation with biological science, computer science, engineering, economics, and sociology in order to flourish and react to future weed issues. Channelling and leveraging multidisciplinary cooperation and weed scientist training, along with information sharing, may assist solve complex problems with more varied and flexible methods, as well as reach more agreement eliminating uncertainties and criticisms.

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