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Bioefficacy of Some Herbicides Against Natural Weed Flora in Wheat Crop

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ABSTRACT

The presence of weeds within the crop may adversely affect production in a number of ways. Weeds compete with crop species for water, nutrients and light and ultimately reduce crop yield. Weeds are unwanted plant species growing in the domesticated crops. The competition of weeds for nutrients may results in such obvious responses as dwarfing in plant size, nutrient starved conditions, wilting and actual dying out of plants. Weeds are notorious yield reducers that are, in many situations, economically more important than insects, fungi or other pest organisms.Weeds have inhibitory effect on crops.The growth of most of the crops involves a constant battle with the weeds in addition to insect pests and diseases. Weeds not only reduce the crop yield, but also deteriorate the quality of the produce thereby, reducing its market value. Weeds reduce yield by affecting the sunlight reaching the plants. In some more serious cases it may lead to complete failure of crop.Therefore, the eradication of weeds from the crop fields is essential for obtaining maximum returns. The various methods for eradication of weeds are hoeing, weeding, dabbing, tillage, bar harrowing, crop rotation biological and chemical controls. The present review explains bioefficacy of some herbicides against natural weed flora in wheat crop.

Keywords: *wheat, herbicides, bioefficacy, weed, crop, fields, production*

I. INTRODUCTION

Indo-Gangetic or northern plains of India are mostly comprised of wheat-rice cropping system. The major weeds prevalent in wheat fields are dicot and monocot, grown in Rabi season viz. Bathua (*Chenopodium album*), Gazari (*Fumaria parviflora*), Katili (*Cersium arvensis*), Krishnneel (*Anagallis arvensis*), Akari (*Vicia hirsuta*), Sengi (*Melilotus alva/Meliotus indica*), Chatari matari (*Lathyrus aphaca*), Satyanashi (*Argemone maxicana*) etc. Likewise, monocot weeds viz., Gehusa/Gullidanda / Gehun ka mama (*Phalaris minor*), wild oats (*Avena fatua*), Piazi (*Asphodelus tenuifolius*) etc. that impose serious problems in wheat fields. In addition to these, doob (*Cynodon dactylon*) is a major perennial weed. The most noxious weed in wheat field is *Phalaris minor* Retz. (Littleseed canary grass). Surveys of wheat crops in the states of Punjab and Haryana established *P. minor* as the most dominant weed of wheat in northwest India. It is very difficult for the farmers to identify due to their resemblance with the wheat plants in early stages of growth. [1,2] Its infestation has been a longstanding management problem for farmers. Its morphological similarity and competitive fast growth with wheat are important problem. The weed problem dates back to green revolution of dwarf wheat varieties. Untreated weed infestation can result in dramatic reduction in wheat yield by 57%, therefore farmers are being forced to harvest immature crops. Complete failure of crop can occur in extreme cases.[3,4]

Traditional methods of weed control such as crop rotation, manual hoeing or tractor drawn cultivator and costly labor have made the use of herbicides popular among Indian farmers. Keeping the importance of these circumstances in view, it is necessary to select the suitable chemicals capable of controlling effectively and economically all the type of weeds present in wheat crop. There are many kinds of chemicals (herbicides) which are used for controlling the weeds. The herbicides are most effective in controlling annual as well as perennial weeds. However, it is essential to select an appropriate kind of chemical and to use it at a specified rate; otherwise they may damage the crop. It should be kept in mind that the chemicals not only destroy the weeds but also get mixed with air, water and soil. Crops take the chemicals from the soil due to which their effect remains in crops. However, the eradication of weeds through chemicals is considered suitable for more area during short period of time. Herbicide is a chemical used to kill or inhibit the growth of weeds and other unwanted plant pests. Herbicides can be classified in several ways, including the weed control spectrum, labeled crop usage, chemical families, mode of action, application timing/method, and others.[5,6]

II. Discussion

Contact herbicides kill only the plant parts in contact with the chemical, whereas systemic herbicides are absorbed by the roots or foliage and translocated throughout the plant. Herbicide activity can be either selective or nonselective. Selective herbicides are used to kill weeds without significant damage to desirable plants. Nonselective herbicides kill or injure all plants present if applied at an adequate rate.

To be effective, herbicides must adequately be in contact with plants, be absorbed by plants, move within the plants to the site of action without being deactivated, and reach to toxic levels at the site of their action. The term "mode of action" refers to the sequence of events from absorption into plants to plant death, or, in other words, how an herbicide works to injure or kill the plant. A number of weed species that were once susceptible to and easily managed by certain herbicides have developed resistance with time. These weeds are no longer controlled by applications of previously effective herbicides. As a result the repeated use of a specific type of herbicide on the same land has developed resistance in some type of weeds to these chemicals. Their application can therefore result in visible crop injuries i.e., leaf chlorosis, necrosis, plant deformations, decolorization, leaves withering, growth retardation[7,8]

The effect of isoproturon was investigated in two wheat cultivars (*Triticum sativum* L. cvs. castan and esquilache) and a weed (*Lolium rigidum* Gaud.) and reported that root growth inhibition was considerably significant in esqilache. Further, the use of isoproturon affected the ultrastructure of photosynthetic apparatus of wheat cv esqilache and decreased the activity of ribulose bisphosphate carboxylase. A decrease in protein and chlorophyll content was also observed.

The grain yield was poor. The content of chlorophyll significantly decreased even after the exposure to 2 mg/kg of isoproturon, the chlorophyll content decreased by 11% as compared with the control. Exposure of wheat plants to isoproturon led to lipid peroxidation in roots and leaves. Sharma and Bandana conducted an experiment to study the effect of isoproturon on chlorophyll and sugar content in wheat leaves at different stages of growth. The treatments included control, handweeding (twice) and three concentrations of isoproturon (35 DAS) viz. 1.0 kg/ha, 1.0 kg/ha + 0.1% surfactant and 1.5 kg/ha. All the three isoproturon treatments resulted in a decrease in chlorophyll and sugar content in wheat leaves at 30 d after herbicide application[9,10]

Malik showed that under field conditions, at post-emergence isoproturon at 1000 g/ha 32 d after sowing failed to control littleseed canarygrass and as a result wheat grain yield decreased by 65% compared with the weed-free control. Singh reported that dry weight of S biotype was significantly reduced at 0.25 kg/ha of isoproturon. Toxicity of isoproturon to wheat and the R biotype increased several fold when P-450 inhibitors were added to herbicide solution. Chokkar and coworkers showed that infestation of isoproturon resistant population caused > 65% wheat grain yield reduction with the recommended rate of isoproturon (1000 g ha^{-1}) application. Similarly, an experiment on isoproturon treated maize showed reduced fresh and dry weight of shoots and roots as well as chlorophyll and carotenoid contents of 10 d old maize seedlings during the following 20 d.[11,12]

III. Results

Herbicides are used to manage unwanted vegetation or weeds but their inappropriate use causes damage to non-target plants as well.

Plant hormones have been cited to play an important role in regulating plant responses to a wide range of biotic and abiotic stresses such as herbicidal phytotoxicity. It has now been found that the compound 2,4-Dichlorophenoxyacetic acid is suitable for protecting cultivated plants against the phytotoxic action of clodinafop-propargyl. Two field experiments were performed to study the reversal effect of glyphosate induced phytotoxicity on growth and yield and its components of fava bean by the application of growth factors, i.e., growth regulators, amino acids and nutrient elements at different concentrations. GA_3 alone or in a mixture with cytokinin reversed the phytotoxic effect of the glyphosate herbicide on decreasing the plant height. Cytokinin at 4/1000, as well as GA_3 at 50 ppm, reversed the phytotoxic effect of glyphosate herbicide on decreasing the dry weight/plant, the number and dry weight of pods, seed yield per plant and per ha. Brassinosteroids enhance resistance of plants to various stresses such as cold, fungal infection, herbicide injury and salt. BRs reduce the damaging effects of simazine, butachlor or pretilachlor in rice. Reduction in the residue levels of various pesticides in cucumber (*Cucumis sativus* L.) were also reported. BRs also increased the ability of resistance in plants against a wide variety of environmental and other stresses like herbicide safening under field conditions. Analyses of chlorophyll fluorescence together with the measures of photosynthetic CO_2 assimilation and plant growth indicate that the harmful effects caused by s-triazine herbicides can be alleviated by brassinosteroids. A group of chemically diverse compounds called safeners having unique ability to protect grass crops from herbicide injury by increasing the expression of genes encoding herbicide-metabolizing enzymes, such as the glutathione S-transferases (GSTs), cytochrome P450 monooxygenases (P450s), and several others. Safeners stimulate herbicidal metabolism by increasing activity of Glutathione S-transferase (GST) enzymes which detoxify endogenous toxins or xenobiotics. They act as bioregulators by intensifying the detoxification process of some herbicides.[13,14] A group of enzymes catalyzing various oxidative, hydrolytic and conjugation reactions are able to metabolize most of the herbicides. Grossmann also used 2,4-D (auxin) as weed killer for better crop production. Cobb and Reade proposed that for more than 60 y, auxins are being used as herbicides which have low persistence and are unlikely to create environment related problems in future also.[15,16]

IV. Conclusion

To feed the growing population there is a need to increase the wheat production without much dependence on chemicals like fertilizers and herbicides which have unpredictable harmful effects on environment and human health. Herbicide resistant weeds and herbicide toxicity to non-target crops are the major obstructions in the way of high production of cultivated crops. There is a need to improve weed management techniques for better crop production. So, we must adopt environment friendly products like plant hormones which are good weed-killers or alternatively select herbicide resistant crops.[17,18]

Herbicide safeners can also be a good option. These are chemical compounds used in combination with herbicides to make them safer, by reducing the toxic effect of herbicides on crop plants and improve selectivity between crop plants and weed species that are the major target by herbicide. These safeners interact with the receptor proteins of herbicides to downregulate the impact of herbicide at the target. Herbicide safeners improve crop tolerance to herbicides by regulating the expression of genes involved in herbicide metabolism. They interact with those biochemical processes or target proteins whose activity would normally be inhibited by the herbicide. BRs can be considered as safeners, which induce the activity of numerous plant P450s and enhance glutathione conjugation involved in the biodegradation of herbicides.

Herbicide	Weed species	Dosage /ha		Dilution in water (L)	Waiting period (days)
		a.i. (g,kg)	Formulation (g,kg,mL,L)		
Glufosinate-ammonium 13.5% SL (15% w/ v) (post-em)	*Panicum repens, Borreria hispida, Imperata cylindrica, Digitaria sanguinalis, Commelina benghalensis, Ageratum conyzoides, Eleusine indica, Paspalum conjugatum*	0.375-0.500kg	2.5-3.3 L	375-500	15
Glyphosate IPA salt 41% SL (post-em)	*Axonopus compressus, Cynodon dactylon, Imperata cylindrica, Polygonum perfoliatum, Paspalum scrobiculatum, Arundinella bengalensis*	0.820-1.230 kg	2.0-3.0 L	450	21
Glyphosate ammonium salt 5% SL	*Cynodon dactylon, Digitaria sanguinalis, Paspalum conjugatum, Ageratum conyzoides, Biden pilosa, Cyperus rotundus, Borreria latifolia, Euphorbia* spp., *Imperata cylindrica*	1.5 kg	30 L	500	7
Glyphosate ammonium salt 71% SG	*Acalypha indica, Sida acuta, Ipomoea digitarea Çychorium intybus, Digera arvensis, Digitaria sanguinalis, Paspalum conjugatum, Ageratum conyzoides, Cynodon dactylon, Cyperus rotundus, Eragrostis* spp.	2.13 kg	3.0 kg	500	7

Various safeners which can be used for wheat are Cloquintocet-mexyl, Fenchlorazole-ethyl, Mefenpyr- diethyl and Furilazole, but their continuous use can cause their persistence in ground water and indirectly in humans. The use of safeners also results in change of phenolic metabolism in wheat seedlings but its significance is yet to be determined. BRs are natural plant steroids with well-known stimulation of cytosolic antioxidant pool along with quenching enzymes of ROS. However, their role in pesticide metabolism is yet to be established. Therefore, potential use of BRs as natural safeners could prove to be a better choice for protecting cereal crops from herbicide injury. Improved herbicide formulations with low or no toxicity except for the target weeds seems to be the demand of near future in agricultural sector so that it may not pose any further complications in yield improvement and the security of health productivity or food security threat.[19,20]

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