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Weed Management Strategies in Wheat Crop

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Abstract:

Weed infestation is a menace in wheat cultivation worldwide, particularly in India, where wheat, a pivotal cereal crop, is a staple food from the Poaceae family. It leads to significant yield reductions, ranging from 30% to a staggering 80%. Weed species like Wild Oats, Field Bindweed, Canada Thistle, and Setaria highlight the crucial need for effective weed management in wheat cultivation due to their competition and growth interference with wheat plants. The presence of diverse weed species in wheat fields across various agroclimatic conditions, cropping sequences, tillage, and irrigation practices poses a challenge, with *Phalaris minor* as the predominant grassy weed in the northern Indian plains, leading to substantial yield losses. Weed control in wheat crops is crucial to prevent competition for resources and achieve optimal yields, utilizing various approaches like herbicides, crop rotation, and mechanical methods. Crop rotations, like sorghum-wheat for reduced weed issues and mungbean-wheat for enhanced wheat yield, proved essential in effective weed management. Mechanical and physical methods of weed management in wheat include practices such as hand weeding, hoeing, tilling, mulching, and using mechanical weeders to physically remove or suppress weeds. Mechanical weed control is labor-intensive and requires special tools, making herbicides the more preferred and efficient choice, especially in large-scale farming. Herbicides are popular among wheat growers for their cost-efficiency and effectiveness. Yet, overusing them can lead to herbicide-resistant weeds, endangering wheat production's sustainability. To ensure long-term success, it's vital to adopt a balanced approach by integrating various weed management strategies.

Keywords: Culture Methods, Mechanical Methods, Herbicides, IWM

I Introduction:

India, the second-largest wheat producer globally after China, plays a pivotal role in meeting the world's wheat demand, contributing approximately 13.5% of global wheat production. Wheat holds the second position among essential food grain crops in India, following rice. The nation dedicates a vast expanse of land, around 30.54 million hectares, to wheat cultivation, resulting in an impressive production of 109.52 million tonnes and an average productivity of 34.64 quintals per hectare (Kumar *et al.*, 2022). Notably, Rajasthan stands as the fourth most significant state in terms of both wheat cultivation area and production, with approximately 3.09 million hectares under wheat, yielding 12.02 million tonnes, and boasting an average productivity of 38.85 quintals per hectare, according to the data from 2021-2022 (GOR, 2021). Despite these impressive numbers, wheat farming in India faces a formidable challenge in the form of weed infestation, which can significantly hamper production. Inadequate weed management practices have been shown to cause up to 66% yield reduction, a loss that hinges on factors such as weed densities, the composition of weed flora, and the duration of infestation. Traditionally, cultural and manual weed management practices have been used, but they are labor-intensive and time-consuming. As a result, chemical weed management has emerged as a more cost-effective and efficient approach compared to manual weeding, making it essential for increasing crop production while reducing production costs. Additionally, crop rotation can serve as a valuable tool in weed management, as it can alter the timing of weed emergence. Research indicates that small grain crops, such as wheat, require less intensive weed control compared to larger grain crops like maize or soybean. In the context of weed management, it's important to note that grass weeds tend to dominate in rice crops when left uncontrolled, whereas broadleaf weeds are more prevalent in wheat fields, leading to significant yield losses. This common challenge of managing weeds in wheat demands innovative strategies. Hence, this study aims to identify effective and economically viable herbicides to manage weeds in wheat crop, ultimately ensuring maximum yields and economic benefits.

II Literature Review:

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Weed Flora and Competition in the Wheat Crop The variation in weed flora within wheat crops across different areas and fields is influenced by environmental conditions, irrigation, fertilizer use, soil type, weed control practices, and cropping sequence (Chhokar and Malik, 2002; *Dixit et al*., 2008). In different wheat growing zones in India, various weed species such *Anagallis arvensis* L., *Argemone mexicana* L., *Avena fatua* L., *Avena ludoviciana* Dur., *Asphodelus tenuifolius., Carthamus oxycantha, Chenopodium album* L., *Chenopodium murale* L., *Convolvulus arvensis* L., *Coronopus didymus* L., *Circium arvense* L., *Euphorbia helioscopia* L., *Fumaria parviflora., Lathyrus aphaca* L., *Malva neglecta, Malva parviflora, Medicago denticulata, Melilotus alba., Melilotus indica, Phalaris minor Retz., Poa annua., Polygonum plebejum., Polypogon monsplensis* L., *Rumex dentatus* L., *Solanum nigrum, Spergula arvensis* L., *Stellaria media, Trigonella incise., Trigonella polycerata, Vicia sativa* L. are associated with the wheat crop (Malik and Singh, 1993). *Phalaris minor* and *Rumex dentatus* are major weed concerns in irrigated wheat fields in India. *Phalaris minor* is problematic in heavy soils, while wild oats prevail in lighter soils. Both weeds, especially *P. minor* and *Rumex dentatus*, can significantly reduce wheat yields under heavy infestation. Weeds pose a significant threat to crop production by competing with crops for essential resources like moisture, nutrients, light, and space. In the rice-wheat system, early emergence of weeds, particularly Phalaris minor and wild oats, results in severe competition with wheat, causing yield losses ranging from 20 to 32 percent (Mongia *et al*., 2005). The shift to dwarf wheat varieties during the green revolution exacerbated the weed problem, as Phalaris minor and wild oats became more prominent, leading to substantial yield reductions and, in extreme cases, complete crop failure. Depending on the intensity of these weeds, yield losses in the range of 10 to 80% may be affected (Cudney *et al*., 1991). Timely weed control during the critical 30-45 days after sowing is crucial to minimizing these losses, but many farmers tend to delay herbicide applications.

2.1 Approaches to Weed Management in Wheat Crop

Optimal yield and quality in wheat crops necessitate the crucial management of weeds, which crops compete with for resources like sunlight, nutrients, and water, and which can harbor pests and diseases. Minimizing these negative impacts requires the implementation of essential

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weed management strategies. Cultural practices, mechanical control chemical and integrated weed management represent common approaches employed in wheat crops.

2.2 Cultural Weed Management

The pronounced effects of weed-crop interference are influenced by cultural practices such as the time and method of sowing, crop density and geometry, crop rotation, crop varieties, and the dose, method, and time of fertilizer application, as well as the timing and method of irrigation. Adjusting the date of sowing to discourage weed seed germination without compromising crop yield is crucial. Early sown wheat (last week of October) reduces infestation by *P. minor* due to suboptimal germination temperatures. However, early sowing increases the population of wild oat (*Avena ludoviciana*) compared to late sowing (Chhokar *et al*, 1999; Singh *et al*., 1995). Monoculture increases weeds with the same life cycle as the crop, but incorporating crops with different seeding and maturity times disrupts the life cycle of economically important annual weeds. Crop rotation, by growing alternate crops instead of wheat for two or more years, reduces soil weed seed banks to low levels, facilitating easier management. Closer row spacing (15 cm) with 50% more seeds and cross sowing reduces weed population and dry weight in wheat. Cross sowing improves plant orientation, positively impacting crop yield through reduced weed infestation. Using competitive cultivars with closer or cross sowing is suggested to minimize herbicide use and north-south row orientation may reduce weed emergence through better ground shading (Chhorkar *et al*., 2012).

Optimizing soil moisture for weed control involves adjusting conditions favoring wheat germination over moisture-dependent weeds like *P. minor* and *Rumex dentatus*, allowing effective management without compromising crop establishment (Chhokar *et al*., 1999). Tillage influences soil characteristics, impacting both crop and weed emergence, and alters weed seed distribution in the soil profile, potentially changing weed population dynamics.

Shifting from intensive tillage to reduced or no-tillage systems especially zero tillage and zero tillage with crop residue of previous pulses crop can profoundly impact weed dynamics,

microclimate, and flora, thereby influencing herbicide effectiveness in wheat production (Choudhary and Sharma, 2023).

III Methodology

3.1 Mechanical Weed Management

Weed removal in wheat involves the use of various tools and implements, including manual methods such as hand weeding and uprooting. While manual weeding is effective, it comes with challenges of requiring a significant amount of manpower and time. The feasibility of manual weeding is further restricted by the high cost of labor and its scarcity in some agricultural settings (Chauhan *et al*., 2003).

Mechanical weeding is another approach, but it faces difficulties when weeds closely resemble the crop, such as in the case of *P. minor* and *Avena ludoviciana* before flowering in wheat fields. The morphological similarity makes it challenging to selectively target weeds without affecting the crop. Additionally, implementing mechanical weed control becomes particularly difficult in fields where wheat is broadcast-sown, as precision in weed removal is compromised (Chhorkar *et al*., 2012).

3.2 Chemical Weed Management in Wheat Crop

Chemical weed control is preferred in wheat due to its higher efficiency, cost-effectiveness, and minimal crop damage compared to manual weeding. Proper herbicide selection, dosage, and application at the right time are crucial for effective weed management. Grass weeds pose a significant challenge in wheat, and post-emergence herbicides, applied 7-10 days after the first irrigation, are commonly adopted. The efficacy of herbicides can be enhanced through optimal application methods, with studies indicating the importance of timely application. While sulfosulfuron, Atlantis and pendimethalin are effective against both grass and non-grass weeds, other herbicides like clodinafop, fenoxaprop, tralkoxydim, and pinoxaden specifically target grasses. Mechanical weeding using a cultivator or wheel hoe is feasible in line-sown wheat crops, reducing weed competition and offering an alternative approach. However, careful consideration is needed for the potential drawbacks of chemical applications,

such as the risk of malformation and drift-related issues with 2,4-D herbicides.It involves the removal of weeds by various tools and implements including hand weeding and uprooting. Manual weeding though effective but involves considerable amount of man-power and time. Due to costly and scarce labour its feasibility is very less. Mechanical weeding is also difficult, where weeds resemble morphologically to crop eg. *P. minor* and *Avena ludoviciana* before flowering in wheat. Also, mechanical weed control becomes difficult in broadcast sown wheat.

In a study conducted by Balyan *et al*. (1988), optimal weed control with Isoproturon was observed when applied 35 days after sowing (DAS), emphasizing the importance of timely application. Metsulfuron, 2,4-D, and Carfentrazone are major herbicides for broadleaf weed control in wheat (Chhokar *et al*., 2007), and their efficacy is contingent on proper spray technology. Sulfosulfuron + Metsulfuron-methyl and Bromoxynil + MCPA with Clodinafop propargyl were effective in reducing the populations of P. minor and Lolium rigidum (Zand *et al*., 2010). Meena and Singh (2011) found that 2,4-D .Na. salt @625 g ha^{-1} had the maximum effect on plant height, ear head length, and the number of grains per ear head compared with unchecked weed. Sharma and Kumar (2011) determined that the most economical and efficient weed management for high wheat yields involved post-emergence application of sulfosulfuron @25 g/ha at 30 DAS. Jaiswal *et al*. (2014) found that Total (Sulfosulfuron + Metsulfuron) significantly higher weed control by 89.5% compared to the weedy check. Meena, *et al*. (2017) reported that application of tank mixed metsulfuron + sulfosulfuron mixture provided maximum per cent reduction in density and dry matter by 90.05 and 95.35 per cent of total weeds over unweeded control followed. Kumar *et al*. (2019) the highest grain yield was recorded with the pre-emergence application of pendimethalin at 2.5 L ha^{-1} followed by the post-emergence application of Atlantis at 400 g ha^{-1}. Banerjee *et al*. (2019) reported that higher mean numbers of effective tillers (355.4 m^{-2}), ear length (12.5 cm), number of grains per ear (42.2), test weight (74 g), and grain yield (3.24 t ha^{-1}) in wheat crop were recorded with the post-emergence application of Pinoxaden at 352.94 g ha^{-1}. Vipil *et al*. (2021) recorded higher mean seed and straw yields in wheat crop (5.80 t and 8.55 t ha^{-1}, respectively) with the post-emergence application of clodinafop + metsulfuron at 60 + 4 g ha^{-1}.

IV Results and Discussion:

4.1 Integrated Weed Management in Wheat Crop

While weeds are efficiently controlled by chemical herbicides, resulting in positive impacts on yield and its components, the environmental and health risks posed by these herbicides cannot be overlooked. Extended residues in the soil can adversely affect vital ecosystems. The need for an integrated and diverse approach in weed management is underscored by recognizing the varying responses of weed flora to different control methods (Buhler, 2002). Integrated Weed Management (IWM) involves combining physical, chemical, mechanical, and cultural control techniques. Focusing on understanding the causes of weed problems, IWM aims to optimize crop production and profit through preventive tactics, scientific knowledge, monitoring procedures, and efficient control practices. The long-term goal of IWM is to minimize weed density and seeds in the soil without degrading the ecological environment (Hartzler & Buhler, 2007). The integration of cultural methods, hand weeding, and pre- or post-emergence herbicide applications is essential for effective weed control in wheat fields. Mustafee (1991) emphasized the judicious combination of cultural and chemical methods for weed control. For instance, superior weed control was observed with a pre-emergence spray of Isoproturon or Methabenzthiazuron, or Terbutryn combined with one hand-weeding at 40 DAS compared to herbicide use alone. This highlights the effectiveness of integrating both mechanical and chemical control for weed management in wheat. Researchers have reported the profitability of wheat crops through reduced tillage combined with hand weeding and 2,4-D application (Verma and Kumar, 1985). Increased seed rate in wheat has also shown effectiveness in weed control (Auškalnienė *et al*., 2010). IWM is characterized by the careful integration of all available weed control tactics to prevent weed development, keeping herbicide use economically justified with minimum risks to human health and the environment (Ferrell *et al*., 2001). In zero tillage sowing, the increased soil strength, along with pre-seeding herbicide application, has been effective in reducing Iinfestation in wheat crops (Choudhary and Sharma, 2023). Additionally, replacing wheat with alternative crops and rotating with green fodder crops has proven effective in reducing the weed seed bank (Chhokar *et al*., 2012).

V Conclusion:

Managing weeds in wheat is vital for sustaining production. Cultural practices, including optimal sowing times and crop rotation, contribute to effective weed control. Mechanical methods, though effective, are labor-intensive. Chemical weed control is common but risks herbicide resistance. Integrated Weed Management (IWM) offers a holistic approach, combining cultural, mechanical, and chemical strategies. In India, a key wheat producer, regional customization of weed management strategies is crucial for optimal yields and sustainable production, ensuring economic viability while minimizing environmental and health impacts. A balanced, diversified approach is essential for long-term success in weed management.

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