Integrated Weed Management in Wheat

Tegbir singh

Student

Lovely Professional University

Dr. Gurpreet Singh

Assistant professor

Lovely Professional University

Abstract

Management strategies must be developed to prevent selection and spread of herbicide resistant populations. For control of multiple herbicide resistant *P.minor* populations (resistant to isoproturon, clodinafop and sulfosulfuron) pendimethalin, trifluralin, pyroxasulfone, metribuzin and terbutryn are effective. Also, the multiple herbicide resistant populations showed sensitivity to glyphosate and paraquat. However, for efficient weed management, the non-chemical weed management tactics should be adopted in conjunction with chemicals (like herbicide mixture and rotation, optimum spray time, dose and methods). Some of the non-chemical agronomic strategies like tillage, sowing time, sowing methods, competitive crop cultivars, higher crop density, closer spacing, irrigation, fertilization, crop rotation and sanitation practices (weed-free crop seeds and manure) can be adjusted and adopted in such a manner that they provide the competitive edge to the crop over weeds.

Keywords: weed, wheat, herbicide, chemical, method.

INTRODUCTION

Wheat is an important crop worldwide and in India it is the second most important staple food after rice. Its production increased from a meagre 11.0 million tons during 1960-61 to 93.51 million metric tons during 2012-13 due to the adoption of short stature high yielding varieties long with increased fertilizers, irrigation and herbicides use. Weeds account for about one third of total losses caused by all pests. For realizing full genetic yield potential of the crop, the proper weed control is one of the essential ingredients. Weeds not only reduce the yield but also make the harvesting operation difficult. Therefore, for sustaining food grain production to feed ever- increasing population and ensuring food security, effective weed management is very essential. Weed competition Introduction of high yielding dwarf wheat varieties changed the spectrum of weed flora from dominance of broadleaf weeds in the 1960s to mixed flora of broadleaf and grassy weeds in early 1970s and then the dominance of grass weeds especially, *Phalaris minor* in late 1970s. The chemical weed control, therefore, became a necessity in late 1970s. Herbicides were introduced in 1979-80, weed flora changed in favour of complex weeds species in late 1980s and then again in favour of *P. minor* during the early 1990s with evolution of herbicide resistance (Malik and Singh, 1993). Weeds have enjoyed dominance over crop basically because of poor agronomic management. To introduce good agronomic practices and the ecology, it is important to understand the competition between weeds and the wheat crop. Weeds compete with crop plants for moisture, nutrients, light and space, thereby depriving the crop of vital inputs. Therefore, weed competition is one of the most important constraints in crop production. Weed-crop competition begins when crop plants and weeds grow in close proximity and their root or shoot system overlaps. The competition becomes severe

due to more smothering effect, when weeds emerge earlier than the crop. In ricewheat system, due to enough soil moisture after harvesting of rice, weeds emerge earlier than wheat or along with wheat crop. Losses in wheat yield are primarily due to reduction in tillering. The critical period of weed control in wheat is 30-45 days after sowing and crop should be kept weed free during this period. Majority of the farmers are not adhering to this critical period for the management of weeds and they mostly delay the herbicide application.

NON-CHEMICAL METHODS OF WEED CONTROL

Stale seed bed preparation:

In this technology weeds seeds are encouraged to germinate through application of one to two pre-sowing irrigations. The emerged weed seedlings are then killed through ploughing or by the use of non-selective herbicides. (paraquat, glyphosate, or glufosinate). This technique is effective not only in reducing weed emergence during the crop season but also in reducing the weed seedbank (Kumar and Ladha, 2011; Singh *et al*., 2009).

Crop Rotations:

Mono-cropping facilitates an increase in weed species that are able to effectively compete with that crop or able to overcome competition through some avoidance mechanism. Weed species with similar life cycles to that of the crop tend to be the greatest problem. Winter weeds are predominant in winter crops and summer annual weeds proliferate in spring-planted crops (Moyer *et al*., 1994). The crop rotations which are diverse in nature can cause a shift in weed species composition and are the cornerstone of integrated weed management (Liebman *et al*., 2001). Knowledge of theses shifts can help in changing the composition of the weed seed bank from undesirable to easy-to-manage species. Singh *et al*., (2008) reported that rice-wheat- greengram sequence recorded lowest population of all the three groups of weeds followed by rice-wheat, rice-chickpea and rice-pea sequence. Diversification of the area under rice-wheat cropping system will not only bring changes in weed spectrum but will also create soil conditions unfavourable for *Phalaris minor*. Loeppky and Derksen (1994) reported that quackgrass [*Elytrigia repens* (L.)] could effectively be controlled through use of diverse crop rotations. Cropping sequences also dictate herbicide use and these factors often interact to affect weeds. Replacing wheat with winter maize can take care of due to use of atrazine in winter maize (Walia *et al*., 2006). Crop rotations including cereal, oilseed, and pulse crops allow for greater herbicide choice over years and avoid continuous use of the same herbicide which may select for weed resistance. In heavy soils, infestations of wild oats that predominated in maize–wheat systems were completely eliminated by growing rice instead of maize (Gill and Brar, 1975).

Tillage:

Tillage affects weed management, weed seed production and pattern of soil disturbances. *P. minor*, which germinates from upper soil layers, can be buried by deep cultivation. Zero tillage technique integrated with timely planting of wheat (October sowing)has shown promising results in reducing *P. minor* infestation and higher grain yields. Zero tillage has been found helpful in reducing the population of P. minor (Chhokar *et al*., 2007; Franke *et al*., 2007). The first emergence flush, which was the most important flush affecting crop–weed competition was about 50% lower in no tillage than in conventional tillage (Franke *et al*., 2007). Chhokar *et al*. (2007) estimated 39% lower biomass of *P. minor* under no tillage compared with conventional tillage because of lower density. So no tillage played an important role in the controlling of *P. minor*. Ram *et al*. (2005)found that raising wheat crop on raised bed can be used to reduce *P. minor* in bed planting the upper 1-2 cm soil layer becomes dry and weed seed can not germinate in the upper soil. So raised bed planting not only save irrigation water but also reduce the weed problem. Dev *et al*. (2013) reported that density and dry matter accumulation of

weeds in no tillage was lower than conventional tillage. They reported that it might be due to the fact that *Phalaris minor* seeds, which were in deeper soil layer comes to upper soil layer due to conventional and reduced tillage and get germinated in conducive environment.

Seed rate and sowing methods:

The role of increasing crop density and decreasing row spacing in reducing competitiveness and seed output by weeds has been reported in several studies. The establishment of a crop with a more uniform and dense plant distribution can increase its ability to suppress weeds. This is due to more rapid canopy closure that better shades weeds.Shallow planting of vigorous seed in narrower rows and at higher seeding rates will encourage uniform and dense crop stands. Higher grain yield were reported when the row spacing was reduce from 23 cm to 8 cm in both weed- free and weedy conditions (Champion *et al*., 1998). Tillering capacity and early ground cover have been reported highly correlated with good weed suppression ability (Whiting *et al*., 1990). Narrow row spacing (15 cm) reduced *P. minor* biomass by 16.5% compared with normal spacing of 22.5 cm (Mahajan and Brar, 2002). Recent studies reported that close spacing of 15 cm recorded to be more competitive than 20 cm row spacing (Anonymous, 2012).

Sowing time:

Weed species have specific soil temperature and moisture requirements for emergence and establishment. If sufficient differences exist between the crop and weed in their germination requirements, then seeding date may be manipulated to benefit the crop. The sowing time of crop should be recommended so that it is maximum favourable for crop growth and development and least favourable for weed germination and growth. The early sowing (25th October to 10th November)of wheat is preferred because temperature is less favourable for *P. minor* germination and when *P. minor* germinates after first irrigation the crop is more competitive compared to late sowing (Walia *et al*. 2005). Similarly, *Avena ludoviciana* can be reduced by planting wheat late in the season. However, length of delayed sowing of improved weed management has to be offset against reduced yield due to shortened growing season. Under timely planting conditions, PBW- 343 and WH-542 were equally competitive with *P. minor* (Chahal *et al*., 2003; Kaur *et al*., 2003; Mahajan and Brar, 2002), but under delayed sowing conditions, PBW-343 is superior to other cultivars against *P. minor* (Kaur *et al*., 2003).

Crop Fertilization:

Fertilizer timing, dose, and placement can be manipulated to reduce weed interference in crops (Di Tomaso, 1995). Nitrogen fertilizer is known to break weed seed dormancy and thus may directly affect weed densities. Blackshaw, (2004) documented that the growth response of many agricultural weeds to added nitrogen is similar to or greater than that of wheat. Nitrogen can markedly alter crop weed competitive interactions and, depending on the weed species and density, nitrogen fertilizer can increase the competitive ability of weeds more than that of the crop, and crop yield remains unchanged or actually decreases in some cases (Ampong-Nyarko and de Datta, 1993). Fertilizer placed in narrow bands below the soil surface near to crop row compared to being surface broadcast has been found to increase crop competitiveness with weeds (Kirkland and Beckie, 1998). Side-row banding of nitrogen fertilizer for four consecutive years of zero-till barley production reduced green foxtail levels below those causing economic injury. Dodamani and Das (2013) reported that the natural weed infestation including *Chenopodium album*, and the pure stand densities of 128 and 64 /m2 inflicted more yield losses at 120 than 60 kg nitrogen/ha. But, at lower densities up to 32 weeds/m2, increasing nitrogen levels favoured wheat more, resulting in greater crop-weed balance at 120 than at 60 kg N/ha. Banisaeidi *et al.* (2014) reported that increased plant density and nitrogen fertilizer can improve spring wheat competitiveness and reduce grain yield loss, wild oat seed production and biomass.

Surface residue mulch:

The use of cover crops and their residues to suppress weeds, particularly in reduced tillage systems, has shown potential to manage weeds. Because surface retained residues provide physical barrier to the emerging weeds, delaying germination and increasing weed seedling mortality. Erenstein, 2002 reported that mulching reduced the weed dry matter due to physical hindrance and reduced solar radiation reaching the weeds. Ram et al. (2013) reported that application of 6 t ha -1of straw mulch reduced the weed dry matter by 50.9% compared to no mulch. Earlier studies by Ahmed *et al*. (2007), Sidhu *et al*. (2007) and Kumar et al. (2013) have s hown the suppressive effect of mulching on weed population in wheat. The release of allelopathic compounds from surface retained residue also reduces the weeds (Yenish *et al.*, 1995).

CHEMICAL WEED CONTROL

In wheat, chemical weed control is preferred over manual and mechanical methods because of its better efficiency along with less cost and time involvement. Herbicides cause no mechanical damage to the crop that happens during manual weeding. Moreover, the control is more effective as the weeds even within the rows are killed, which invariably escape, because of morphological similarity to crop, during mechanical control. Effective weed control depends on the proper selection of herbicides depending on the type of weed flora infesting the crop and further herbicide should be applied at optimum dose and time using proper application technology. Wheat crop is generally invaded by both grass and broad-leaved weeds but the major challenge offered is by grass weeds. This is due to narrow selectivity between grassy weeds and wheat crop being both of grass in nature exhibits similar physiology and reaction to herbicides compared to broad-leaved weeds.

Herbicides effective against isoproturon resistance biotypes of *P. minor* are sulfosulfuron, clodinafop, fenoxaprop, tralkoxydim, pendimethalin, Atlantis and pendimethalin are effective against both grass and non-grass weeds, whereas, clodinafop, fenoxaprop, tralkoxydim and pinoxaden are specific to grasses. However, sulfosulfuron and pendimethalin are not effective against *Rumex dentatus* and *Avena ludoviciana*, respectively. For control of broad-leaved weeds, 2,4-D has been used for a long time, however, the application of 2,4-D at inappropriate time as well as on sensitive cultivar can lead to yield reduction due to malformation (Pinthus and Natowitz, 1967; Bhan *et al*., 1976). In addition, 2,4-D butyl ester application often results in injury to adjacent sensitive broadleaf crops, due to its volatilization and solution drifting (Zhang *et al*., 2005)as a result it is less preferred by the growers.

Table:1 Herbicides used for weed control

Herbicides	Dose (g/ha)	Time of application	Weeds controlled
2,4-D (Weedmar)	500-800	Post-emergence (30DAS)	Broadleaved weeds (Bathua, Hiranchari, Motha, Kasni, Krishnaneel, etc.)
Sulfosulfuron (leader)	25	Post-emergence (25-30 DAS)	Both broad-leaved weeds and grasses
Clodinofop-propagyl (Topik)	60	Post emergence (25-30 DAS)	Grasses
Fenoxaprop (Puma Super)	100	Post-emergence (25-30 DAS)	Wild oat and Phalaris minor
Metsulfuron Methyl (Algrip)	40	Post-emergence (25-30 DAS)	Broad-leaved weeds

INTEGRATED WEED MANAGEMENT

It is not desirable to depend on single method of weed control. The best approach is integrated weed management in which all suitable methods of weed control are used in a compatible manner to reduce weed population and maintain them at levels below the threshold causing economic injury. Plant density, time of sowing, variety, seed rate, spacing, tillage practices, quantity and time of fertilizer and irrigation water are some of important factors, which influence the weed-crop competition. Regulation of these factors should be such that they give the competitive edge to crop over weeds. The integration of these factors with chemical measure is advisable to avoid the ill effects caused by the sole dependence on the herbicides. Some of the negative impacts of sole dependence on herbicides are evolution of herbicide resistance, weed flora shift and soil and environmental pollution. Also, the continuous dependence on single method of weed control leads to shift of weed flora in favour of more tolerant and difficult to control species and to tackle this problem, there is need to adopt integrated weed management practices. The rising cost of labour and input will wipe out the profits of farmers unless an integrated approach with focused attention of ecology and herbicides is adopted.

CONCLUSIONS

Weed infestation is one of the main biotic constraints in wheat production and productivity. For weed control most of the wheat farmers depend on herbicides due to cost and time effectiveness compared to manual weeding. However, continuous use of same herbicide or herbicides of similar mode and mechanism of action is resulting in the build up of tolerant weed species as well as evolution of resistant populations of weeds. In India, *P. minor* has evolved multiple herbicide resistance and *Rumex dentatus* has evolved sulfonylurea resistance. The evolution of herbicide resistant weeds is a threat to wheat sustainability. Long term strategies to manage or avoid the build up of herbicide resistant and tolerant weeds should include integration of non-chemical methods (crop rotation, stale seed bed, zero tillage, early planting, competitive cultivars and increased seeding rate) with chemical (herbicide rotation and herbicide mixture)for sustainable wheat production.

References

Ahmed, Z.I, M. Ansar, M. Iqbal, N.M. Mainahs. 2007. Effect of planting geometry and mulching on moisture conservation, weed control and wheat growth under rainfed conditions. *Pak. J. Bot.* **39**: 1189-1195.

Ampong-Nyarko, K. and S.K. de Datta. 1993. Effects of nitrogen application on growth, nitrogen use efficiency and rice-weed interaction. *Weed Res*. **33**:269-276.

Anonymous. 2012. Progress Report of All India Coordinated Wheat & Barley Improvement Project 2012-13, Vol. II, Resource Management. Eds: R.K. Sharma, S.C. Tripathi, S. Chander, R.S. Chhokar, R.P. Meena, Anita Meena, A. Verma, Indu Sharma. Directorate of Wheat Research, Karnal, India. P. 205.

Banisaeidi, A.K., E. Zand, A. Modhj, S. Lak and M.A. Baghestani. 2014. Influence of nitrogen and plant density on spring wheat (L*Tr*.)*itainudmoaaets*(*t*L*iv*.*u*) *m Avena ludoviciana* competitiveness. *Int. J. Biosci.* 4: 113-119.

Bhan V.M., P.S. Negi, R.S. Chaturvedi and D.B.B. Chaudary. 1976. Spike malformation by 2,4-D in dwarf wheats. *Indian J. Weed Sci.* **8**: 53-59.

Blackshaw, R.E. 2004. Application method of nitrogen fertilizer affects weed growth and competion with winter wheat. *Weed Biol. Manage*. **4**: 103-113.

Chahal, P. S., H. S. Brar, and U. S. Walia. 2003. Management of Phalaris minor in wheat through

Champion G.T., Froud-Williams R.J., Holland J.M. 1998. Interactions between wheat (*Triticum aestivum* L.)cultivar, row spacing and density and the effect on weed suppression and crop yield. *Annals Appl. Biol*. **133**: 443–453.

Chhokar R.S., R.K. Sharma, A.K. Pundir and R.K. Singh. 2007. Evaluation of herbicides for control of *Rumex dentatus*, *Convolvulus arvensis* and *Malva parviflora*. *Indian J. Weed Sci.* **39**: 214-218

Dev, D., Vivek, S.P. Singh and R. Kumar. 2013. Weed management studies in wheat (*Triticum aestivum)*with herbicides under different establishment methods. *215-219.*

Di Tomaso, J.M. 1995. Approaches for improving crop competitiveness through the manipulation of fertilization strategies. *Weed Sci*. 43:491-497.

Dodamani B.M. and T.K. Das. 2013. Density and nitrogen effects on interference and economic

Erenstein, O. 2002. Crop residue mulching in tropical and semitropical countries: an evaluation of

Franke, A.C., S. Singh, N. Mcroberts, A.S. Nehra, S. Godara, R.K. Malik, and G. Marshall. 2007. *Phalaris minor* seedbank studies: longevity, seedling emergence and seed production as affected by tillage regime. *Weed Res*. **47**: 73–83.

Gill, H. S. and L.S. Brar. 1975. Importance of weedicides in the agriculture of Punjab and Haryana. *Pesticides* **9**: 20–24.

Kaur, H., H.S. Brar, and U.S. Walia. 2003. Competitive ability of wheat cultivars sown on different dates with littleseed canarygrass (R*Ph*et*a*z*l.a*)*r. is minor Ind.ian*:*J. Weed Sci* **35** 21–23.

Kirkland, K.J. and H.J. Beckie. 1998. Contribution of nitrogen fertilizer placement to weed management in spring wheat ()*T.riticum aestivu.m* :5*W*0*e*7*e-d*5*T*1*e*4*c.hnol* **12**

Kumar, V, S. Singh, R.S. Chhokar, R.K. Malik, D.C. Brainard and J.K. Ladha. 2013. Weed

Kumar, V. and J.K. Ladha. 2011. Direct-seeding of rice: recent developments and future research

Liebman, M.C., L. Mohler, and C.P. Staver. 2001. Ecological management of agricultural weeds.

Loeppky, H.A. and D.A. Derksen. 1994. Quackgrass suppression with crop rotation. *Can. J. Plant Sci*. **74**: 193-197.

M. Singh and S. Singh. 2007. The Happy Seeder enables direct drilling of wheat into rice threshold of common lambsquarters in wheat. *J. Pest Sci*. **86**: 611–619.

Mahajan, G. and L.S. Brar. 2002. Integrated management of *Phalaris minor* in wheat: rationale residue availability and other technological implications. *Soil Tillage Res.* **67:** 115–133.

Malik, R.K. and Singh S. 1993. Evolving strategies for herbicide use in wheat. Resistance and integrated weed management. *Proceedings of Indian Society of Weed Science International Symposium on Integrated Weed management for Sustainable Agriculture*, 18-20 November,1993, *Hisar. India* Vol. 1: 225-238.

Mahajan, G. and L.S. Brar. 2002. Integrated management strategies to reduce herbicide use in zero-till rice–wheat cropping systems of the Indo-Gangetic Plains. *Weed Technol*. **27**: 241–254.

Moyer, J.R., E.S. Romain, E.W. Lindwall, and R.E. Blackshaw. 1994. Weed management in conservation tillage systems for wheat production in North and South America. *Crop Prot*. **13**: 243-258.

Pinthus M.J. and Y. Natowitz. 1967. Response of spring wheat to the application of 2,4-D at various growth stages. *Weed Res.* **7**: 95-101.

Ram H, Y. Singh, J. Timsina, E. Humphreys, S.S. Dhillon, K. Kumar and D.S. Kler. 2005b. Performance of upland crops on raised beds in northwest India. *Proc. of Workshop on Evaluation and Performance of Permanent Raised bed cropping systems in Asia, Australia and Mexico.* March 1-3 at Australian Centre for International Agriculture Research Canberra, Australia. *ACIAR Proc.* **121**: 41-58.

Ram, H., V. Dadhwal, K.K. Vashist, H. Kaur. 2013. Grain yield and water use efficiency of wheat (L*Tr*.)*iti*i*ncu*r*em*la*a*ti*e*os*n*t*iv*t*o*um*irrigation levels and rice straw mulching in North Research Bulletin, Punjab Agric. Univ. Ludhiana: 1-32.

Sidhu, H.S., M. Singh, E. Humphreys , Y.Singh, B. Singh, S.S. Dhillon, J. Blackwell, V. Bector,

Singh, R.K., J.S. Bohra, V.K. Srivastava and R.P. Singh. 2008. Effect of diversification of rice wheat system on weed dynamics in rice. *Indian J. weed Sci*. **40**: 128-131.

Walia, U.S., L.S. Brar and B. Singh. 2006. Recommendations for weed control in field crops. West India. *Agric. Water Manage.* **128**: 92-101.

Whiting, A.J.; M.C. Richards and Helen Brown. 1990. Crop competiveness as an aid to weed control in cereals. *Proc. Brighton Crop Prot. Conf., British Crop Protection Council*, 1990. p. 197-200.

Yenish J.P., A.D. Worsham and W.S. Chilton.1995. Disappearance of DIBOA-glucoside, DIBOA, and BOAfrom rye (L*Se*.)*cca*o*lv*e*ecrecre*ro*apl*eresidue. *Aust. J. Exp. Agric*. **47:** 844–854.

Zhang C.X., X.G. He and H.B. Li 2005. Drift injury of 2,4-D butyl ester and remedial measures to cotton. *Hubei Plant Prot.* **1**: 35-36.