INT. J. BIOL. BIOTECH., 3 (1): 209-213, 2006.

EFFICACY OF HERBICIDES ON WEED DENSITY AND GRAIN YIELD OF NO TILL WHEAT

Gul Hassan[1], Naqib Ullah Khan[2] and Mohammad Munir[3]

[1]*Department of Weed Science, NWFP Agricultural University, Peshawar 25130, Pakistan E-mail: hassanpk_2000pk@yahoo.com*
[2]*Department of Plant Breeding and Genetics, NWFP Agricultural University, Peshawar 25130, Pakistan.*
[3]*Crop Protection, Crop Sciences Division, Pakistan Agricultural Research Council, Islamabad, Pakistan*

ABSTRACT

Studies were initiated on Zero tillage and integration of herbicides for wheat production in a rice-based cropping system of Dera Ismail Khan, Pakistan. Zero Tillage vs. conventional tillage regimes were assigned to main-plots, while post em. herbicides (Buctril-M, Affinity and weedy check) were kept into sub-plots. For weed density, there were significant differences ($P<0.05$) for herbicides, while tillage regimes and their interaction with herbicides were non-significant statistically. The tillage plots showed numerically lesser weed infestation than no till plots. As far as the interaction is concerned, both the chemical treatments showed lower weed density as compared to weedy check under either tillage regime. Fleabane exceptionally grew in zero tilled plots. The herbicide Buctril-M outyielded (P<0.05) Affinity and weedy check, but Affinity was statistically at par with the weedy check. The highest net benefit (Rs.5965 ha^{-1}) was achieved under the Zero tilled wheat covered with Buctril-M. The lowest marginal net benefit was attained in the Affinity + zero tillage. It is thus, recommended that zero tillage may be adopted for lucrative income and sustainability of the production system with the use of Buctril-M, in the light of our data set. Adoption of such a resource conservation technology has been a timely intervention to reduce production costs, improve efficiency of natural resource management practices, benefit the environment, and exploit potential of the rice-based system.

Key words: Conventional tillage, grain yield, herbicides, weed density, zero tillage.

INTRODUCTION

The rice-wheat belt is the bread basket and home to more than 600 million people across the South Asia. It is estimated by the FAO experts that approximately 240 million people consume rice and/or wheat produced in the rice-wheat cropping system. Under this system, farmers grow rice in the monsoon (kharif) season followed by wheat in winter (rabi) season. Farmers use this system on nearly 12 million ha in South Asia along large areas of Pakistan, Northern India, Nepal and Bangladesh. China has an additional 10 million ha of rice-wheat area (FAO, 1996).Wheat (*Triticum aestivum* L.) is globally important cereal crop with respect to area and production. Wheat culture both in NWFP, as well as in the whole country is the backbone of the whole agricultural system. In Pakistan, wheat is grown on an area of 8.46 million hectares with a grain production of 21.07 million tons. The average country and provincial productions are limited to 2491 kg and 1324 kg ha^{-1}, respectively (Anonymous, 2002). However, the wheat yield in Pakistan is lower as compared to other advanced countries of the world. There are several reasons for this low yield in the rice-wheat cropping system, but the worst one is late sowing of the wheat crop in rice-wheat belt of Pakistan resulting in reduction of yield by 35 kg ha^{-1} for each successive delay of one day. Similarly weeds in rice-wheat belt cause consequent reduction in wheat yield (Khan, 2001). Fortunately zero tillage technology, which is an important component of conservation agriculture, comprehensively meets the needs of the aforementioned twin problems. Zero tillage is a technique of raising crops without prior land preparation. The technology has been found useful especially for growing wheat crop in the rice harvested fields where its sowing is often delayed due to time involved in land preparation. The technology has shown its worth amongst the farmers because the cost of production is considerably reduced as a result of minimum or zero tillage, water saving and higher yield due to earlier planting of wheat seed directly in rice stubbles, conserving the residual moisture, and also leaving the weeds asleep by not allowing their exposure to light. Thus allowing proper aeration to wheat roots and management of weeds (Khan, 2001; Mann and Ashraf, 2003; Mann *et al*., 2004, Phillips, 1980). No-till also prevents soil erosion, reduces release of greenhouse gases from the soil, improves air quality and protects wildlife habitat and biodiversity (Anonymous, 2004 and Khan *et al*. 2004).

Failure of the seeds to germinate even if required conditions for germination viz. water, oxygen, and light, are available, renders them dormant. It is very astonishing that despite the maintenance of flood to a level of more than 4 inches throughout the rice-growing season, the annual weeds subsequently infest the succeeding crops like wheat and gram in higher intensity, although with an altered composition. There are several features, which render the weed species successful including enormous seed production, early rapid growth and space capture etc. but still is another attribute which confers success to weeds which is dormancy or rest period, which enables the seeds to persist in the soil and survive under the conditions not suitable for plant growth (Karssen, 1982; Harper, 1977). Numerous investigations spread over many years have studied basic and practical aspects of the problem (Crocker and Barton, 1953). Benvenuti and Macchia (1995) showed that the high CO_2 and low O_2 (hypoxia) induced dormancy while Taylorson (1970) reported otherwise. Baskin and Baskin (1985) and Benvenuti ad Macchia (1994) further added that dormancy-non-dormancy transition may be related to changes in membrane properties.

Herbicides have emerged as an excellent toll into the hands of weed managers for managing weeds in wheat (Azad *et al*., 1997; Balyan *et al*., 1983; Brar *et al*., 1999 a & b; Gill and Walia, 1979; Ormeo and Diaz, 1998, Pracyzk *et al*., 1995; Young *et al*., 994; Hassan *et al*., 2003). The role of herbicides in making the zero tillage technology as practicable can not be overemphasized.

It has been observed in Indo-Pak sub-continent that little seed canary grass *(Phalaris minor*) has seriously infested the rice-based cropping system. Moreover, in rice based farms in District Dera Ismail Khan are also infested with meadow peavine *(Lathyrus aphaca)* and common vetch *(Vicia sativa)* [personal observation]. We postulate that heavy infestation of these weeds in the rice based cropping system is due to the differential response of these species to the constant flood maintained in rice crop during its growth. The weeds competitive for niches in the subsequent crops are suppressed due to their seed loss from the seed bank, whereas the seeds of the referred species are rendered dormant, hence over the years their number has increased due to lesser or no infestation of other competitive weeds. Keeping in view the importance of the differential dynamics of weeds in the rice based cropping system; an experiment was carried out under field conditions to investigate the response of weeds under zero tillage vs. conventional tillage and the interaction of tillage regimes with the herbicides.

MATERIALS AND METHODS

An experiment was conducted at Agricultural Research Institute, Dera Ismail Khan during Rabi 2002-3 to investigate efficacy of herbicides on weed density and grain yield of no till as conventional tilled wheat. The experiment was laid out in split plot design with three replications. The tillage regimes (zero vs. conventional) were assigned to the main-plots, while the herbicides (Buctril-M 40 EC or bromoxynil + MCPA and Affinity 50 WDG or carfentrazone-ethyl + isoproturon) were kept in sub-plots. The herbicides Buctril-M and Affinity were applied as postemergence at 1.5 L and 2 kg ha^{-1}, respectively. Cultivar Nasir-2000 was seeded on November 22, 2002 in zero tillage drill or with a common drill in case of conventional tillage main-plots. The sub-plot size of 9 x 3 m^2 was maintained by drilling 100 kg wheat seeds ha^{-1}. Fertilizer was applied @ 120-90-60 NPK kg ha^{-1}. All P, K and half N was applied before sowing and the remaining half N was applied at 1st irrigation. All the agronomic practices were equally adopted for all the treatments. The herbicides were sprayed after the emergence of weeds in proper moisture conditions on 10th January 2003. Data on weed density (m^{-2}) were recorded on 15th February 2003 and subsequently at the time of harvesting the data were recorded on the exceptional growth of *Conyza stricta* (fleabane) in the zero tilled plots. The data were also recorded on grain yield (kg ha^{-1}). Marginal analysis was run on the grain yield data by converting it to the monetary terms, to segregate the most economical treatment as suggested by Jan et al., 2004. Conventional tillage coupled with weedy check was employed as a standard treatment to run the economic analysis. Standard procedures were adopted for recording the data on above traits. The data recorded for each trait were individually subjected to the ANOVA technique by using MSTATC Computer software and means were separated by using Fisher's protected LSD test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

An experiment comprising tillage regimes and herbicides on wheat was carried out at Agricultural Research Institute, Dera Ismail Khan. Data were recorded on various parameters are presented as under:

Weed Density (m^{-2})

There were significant differences ($P<0.05$) in weed density for tillage operations, herbicides and their interaction (Table-1). The predominant weed species in the experiment were field bindweed *(Convolvulus arvensis)*, thistle *(Carthamus oxycantha)*, curly dock (*Rumex dentatus),* common medic (*Medicago denticulata),* indian sweet clover (*Melilotus indica),* wild oats *(Avena fatua)* and littleseed canarygrass *(Phalaris minor)*. On the average, the tilled plots showed slightly lesser, but statistically significant weed population than zero tillage. Both the herbicides have shown significant decrease ($P<0.05$) in weed infestation against the weedy check. The difference between the herbicides was non-significant statistically, however. Affinity although is a broad spectrum herbicide, while Buctril-M is broadleaf weed killer. Thus, the inferences depict that the major competitive damage to wheat was offered by the broadleaf weeds. As far as the interaction is concerned, both the chemical treatments showed the lower and statistically at par weed density as compared to weedy check under both tillage regimes (Table 1). These findings are in agreement with work of Feldman *et al*. (1988) who noticed more diverse weed flora in no-tillage plots than minimum and conventional tillage regimes in wheat. On contrary, Malik et al. (1998), Hobbs and Gupta (2002), Singh *et al*. (2002), Streit *et al*. (2003), Mann *et al*., 2004, and Khan *et al*. (2004) observed 30-52% lesser weed flora in no-till plots than conventional tillage. Our findings however, partially agree with the work of later scholars as the interaction of herbicides with the tillage regimes showed non-significant differences depicting the practical importance of the no till method when supported with the herbicide coverage.

Fleabane *(Conyza stricta)* Occurrence (m^{-2})

The data recorded at harvesting of wheat revealed an unusual infestation of fleabane *(C. stricta)* [Table 2] in zero tilled plots. Fleabane is a worst invasive weed of sugarcane introduced into the area in late eighties probably with sugarcane seed. The species never infests wheat under the conventional tillage in the rice based cropping system. The differential infestation in the two tillage regimes is probably due to the fact that the water borne seeds of the weed had been settling in the rice crop. With the conventional tillage the disturbance damaged the seeds by either burying them deep or exposing them onto the soil surface vulnerable to predation by birds or insects. In zero tillage the seed reserve was safe deposited and with the favorable temperatures it germinated. The data in Table-2 exhibits that the fleabane density was non-significant for the main effects of herbicides as well as their interaction with tillage regimes, but it was significant for the tillage regimes. No fleabane plant vs. 13.44 m^{-2} were recorded for the conventional and the zero tilled regimes, whereas the density across the sub-plots stayed the same in the treated as well as untreated plots, because the herbicides are post emergence, the weed germinated in the end of season hence the herbicides were ineffective and possessed comparable density with weedy check (Table 2). These findings are in agreement with Feldman *et al*. (1988) also noticed more diverse weed flora in no-tillage plots than minimum and conventional tillage regimes in wheat in their studies.

Grain yield (kg ha^{-1})

For grain yield (kg ha^{-1}) [(Table-3] there were significant differences for weed control treatments, while the tillage treatments and their interaction with the herbicides were non-significant ($P<0.05$). The significantly highest yield was recorded in plots sprayed with Buctril–M, which was however, statistically at par with Affinity. The weedy check showed the lowest grain yield in both practices, but statistically at par with the Affinity 50 WDG. The grain yield in across the tillage regimes varied non-significantly, but the conventional tillage plots gave slightly higher yield as compared to the zero or no till plots, of course with the higher cost of production in the former regime. When covered with the Affinity 50 WDG under the conventional tillage produced the highest numerical yield (3080 kg ha^{-1}) [Table 3]. It was closely followed by Buctril-M 50 EC under zero tillage (3072 kg ha^{-1}). Affinity under zero tillage (2563 kg ha^{-1}) produced even lower yield than the weedy check (2592 kg ha^{-1}) with the same tillage method showing the failure of Affinity to mange weeds under the concerned tillage. Streit *et al*. (2003) also observed that post-em weed control was generally better than pre-emergence weed control. Sowing of wheat after mid of November causes reduction in grain yield by one per cent for each successive delay of one day i.e. 35 kg ha^{-1} per day (Hobbs *et al*., 1988). Thus, zero tillage expedites the wheat planting in rice based system which saves the highlighted loss in yield due to delay. The results are in also corroboration with the findings of Azad *et al*., (1997); Balyan *et al*. (1983); Brar *et al*. (1999 a &b); Gill and Walia, (1979); Ormeno and Diaz, (1998); Pracyzk *et al*. (1995); Young *et al*. (1994) and Hassan *et al*. (2003), who observed good weed control and increased wheat yield with herbicides.

Economic Analysis

The marginal analysis of yield data in Table-4 manifest that highest net benefit (Rs.5965 ha^{-1}) was achieved under the Zero tilled wheat covered with Buctril-M. For the net benefit the top scoring treatment was followed by the zero tilled weedy check (Rs.2890 ha^{-1}) and Buctril-M + conventional tillage (Rs.2275 ha^{-1}). The lowest marginal net benefit was attained in the Affinity + zero tillage owing to its exceptionally poor yield. From the aforementioned findings, it is recommended that zero tillage may be adopted for generating lucrative income and sustainability of the production system with the use of Buctril-M, in the light of our data set. The system saves enough money otherwise spent on the imported gasoline for seed bed preparation in addition to the highlighted benefits. Zero tillage, as a resource conservation technology (RCT) integrated with chemical weed control was found more economical by saving time and specially expenditure due to labor, land preparation and irrigation and economizing soil water which is a limiting crop production factor. Development and dissemination of such a resource conservation technology has been a timely intervention to reduce production costs, improve efficiency of natural resource management practices, benefit the environment, and exploit potential to improve living of the farming community.

Table 1. Effect of zero tillage and herbicides on the weed density in wheat.

Herbicides	Tillage	Zero tillage	Means
Buctril-M	2.33 c[1]	2.33 c	2.33 b
Affinity	2.67 c	3.00 c	2.83 b
Weedy Check	7.33 b	11.33 a	9.33 a
Means	4.11 b	5.56 a	

[1]Means sharing a letter in common, in the respective category, do not differ significantly differ at $P<0.05$ by LSD test.

Table- 2. Effect of Zero Tillage and herbicides on fleabane *Conyza stricta* population (m^{-2}) in wheat.

Herbicides	Tillage	Zero tillage	Means
Buctril-M	0.00	12.67	6.33
Affinity	0.00	13.33	6.67
Weedy Check	0.00	14.33	7.17
Means	0.00 b[1]	13.44 a	

[1]Means sharing a letter in common, in the respective category, do not differ significantly differ at $P<0.05$ by LSD test.

Table-3. Effect of zero tillage and herbicides on the grain yield (kg ha^{-1}) of wheat

Herbicides	Tillage	Zero tillage	Means
Buctril-M	3063	3072	3068a[1]
Affinity	3080	2563	2822ab
Weedy Check	2763	2592	2678b
Means	2969	2742	

[1]Means sharing a letter in common, in the respective category, do not differ significantly differ at $P<0.05$ by LSD test.

Table 4. Marginal analyses of zero vs. conventional tillage and herbicides in wheat.

Treatments	Grain Yield kg ha^{-1}	Variable Income (Rs.ha^{-1})	Variable Costs (Rs. ha^{-1})	Savings (Rs. ha^{-1})	Net Benefit (3-4+5)
Buctril-M + Zero Tillage	3072	3090	-	+2875	5965
Affinity + Zero Tillage	2563	-2000	-	+2100	100
Weedy Check+Zero Tillage	2592	-1710	-	+3600	2890
Buctril-M+Conven. Tillage.	3063	3000	725	-	2275
Affinity + Conven. Tillage	3080	3170	1500	-	1670
Weedy Check+Conven. Tillage	2763	-	-	-	-

Price of Buctril-M 1500 ml ha^{-1} @ Rs. 290 per pack of 500 ml.; **P**rice of Affinity 50 WDG 2000 g ha^{-1} @ Rs. 600 per pack of 800 g.
Cost of Land Preparation = Rs. 3600 ha^{-1}; **P**rice of Wheat = Rs 10 kg^{-1}.

ACKNOWLEDGEMENTS

The authors are highly indebted to Agricultural Linkages Program of Pakistan Agricultural Research Council, Islamabad, for sponsoring the research presented in this manuscript.

REFERENCES

Anonymous (2002). *Agricultural Statistics of Pakistan*. Ministry of Food Agriculture and Livestock, Government of Pakistan. Islamabad.

Anonymous (2004). *Water matters for sustainable agriculture: A collection of case studies*. CropLife International pp.12.

Azad, B.S., S. Harbans and H. Singh (1997). Effect of time, methods of application of herbicides and nitrogen on weed control in wheat. *Annals Agric. Res*., 18: 174-177.

Balyan, R.S., V.M. Bhan and S.P. Singh (1983). Evaluation of herbicides in wheat. *Ind. J. Weed Sci*., 15: 43-46.

Baskin, J.M. and C.C.Baskin (1985). The annual dormancy cycle in buried weed seeds: *Continuum BioSci*., 35: 492-98.

Benvenuti, S. and M. Macchia (1994). Effect of ethylene on dormancy breaking imposed by some environmental factors in *Datura straumonium* L. seeds. *Rivista de Agronomia*, 28: 96-101.

Benvenuti, S. and M. Macchia (1995). Effect of hypoxia on buried weed seed germination. *Weed Res. Oxford*, 35: 343-351.

Brar L.S., U.S. Walia and B.K. Dhaliwal (1999a). Bioefficacy of new herbicide for the control of resistant *Phalaris minor* in wheat. *Pesti. Res. J*., 11: 177-180.

Brar, L.S., U.S. Walia and B.K. Dhaliwal (1999b). Performance of clodinafop for the control of wild oat (*Avena ludoviciana*) in wheat. *J. Res. Punjab Agric. Univ*., 36: 187-190.

Crocker, Wm., and L.V. Barton (1953). *Physiology of seeds*. Chronica Botanica Co., Waltham, Mass.

FAO. (1996). *Production Yearbook* Vol. 51. FAO. Rome. Italy.

Gill, H.S. and U.S. Walia (1979). Herbicidal control of *Phalaris minor* Retz. in wheat. *Proc. 7th Conf. of the Asian-Pacific Weed Sci. Soc*., pp. 9-62.

Harper, J.L. (1977). *Population biology of plants*. Academic Press, New York.

Hassan, G., B. Faiz, K.B.Marwat and M.Khan (2003). Effects of planting methods and tank mixed herbicides on controlling grassy and braodleaf weeds and their effect on wheat cv. Fakhre-Sarhad. *Pak. J.Weed Sci. Res*., 9: 1-11.

Hobbs P.R., C.E.Mann and L.Buttler (1988). A perspective on research needs for rice-wheat rotation. In: *Wheat Production* (A.R. Klott, (Ed.). CIMMYT, Mexico. pp.197-211.

Hobbs P.R. and R. Gupta (2002). Resource conserving technologies for wheat in the rice-wheat system. In: *Improving the productivity and sustainability of rice-wheat system: Issues and Impacts* (Ladha (ed.). ASA Special Publications, Madison, Wisconsin, USA.

Jan H., A. Muhammad and A. Ali (2004). Studies on weed control in potato in Pakhal Plains of Mansehra. *Pak. J. Weed Sci. Res*., 10: 101-104.

Karssen, C.M. (1982). Seasonal patterns of dormancy in weed seeds. Pages 243-370. In: *The Physiology and Bio-chemistry of Seed Development, Dormancy and germination*. (A.A. Khan ed.). Elsevier Biomedic Press, Amsterdam.

Khan N.U., S.U.Khan and G. Hassan (2004). Herbicides effect on weed flora and grain yield of zero vs. conventional tillage wheat. *4th Int. Weed Sci. Congr.* (IWSC) June 20-24, 2004 Durban, South Africa. S13MT17P04.

Khan, S. R. A. (2001). Rice-wheat cropping system. *The International Dawn*' 07th May, 2001.

Malik R.K., S.G.Gill and P.R.Hobbs (1998). Herbicide resistance—a major issue for sustaining wheat productivity in rice-wheat cropping system in the Indo-Gangetic Plains, RWC paper series 3, 36 pp., New Delhi India.

Mann R.A. and M. Ashraf (2003). Effect of resource-conserving tillage technology on weeds in wheat crop. First Int. Weed Sci. Conf. October 23-26, 2003 at Agril. Univ. Peshawar, Pakistan. Abst. No.5".

Mann R.A., M. Ashraf and G. Hassan (2004). Wheat establishment with zero-tillage for integrated weed management. *Pak. J. Weed Sci. Res*., 10: 17-24.

Ormeno, N.J. and S.J. Diaz (1998). I. Clodinafop, a new herbicide for the selective control of grassy weeds in wheat. II Selectivity on spring and alternative cultivars. *Agricultura, Tecnica, Santiago,* 58: 103-115.

Phillips S.H. (1980). No-tillage, past and present. In: *No-tillage Research: Research reports and reviews.* (R.E. Philips, G.W. Thomas and R.L. Blevins (Eds.). Pp: 1-6. University of Kentucky, Lexington,.

Praczyk, T., K. Adamczewski, K. Miklaszewska and J. Gorniak (1995). Estimation of Logran Extra 62 WG for weed control in wheat. *Materialy, Sesji, Instytutu, Ochrony, Roslin,* 35: 311-313.

Singh S., A. Yadav, R.K.Malik and H. Singh (2002). Long-term effects of zero tillage sowing techniques on weed flora and productivity of wheat in rice-wheat cropping zones of Indo-Gangetic plains. *Proc. Int. Workshop, Hissar, India*, 4-6 March 2002, CCSHA, Hissar, India Pp. 155-167.

Steel, R.G.D. and J.H. Torrie (1980). *Principles and procedures of statistics a biological yield approach*, 2nd ed. McGraw Hill Book Co., Inc. New York.

Streit B., S.B.Rieger , P. Stamp and W.Riccher (2003). Weed population in winter wheat as affected by crop sequence, intensity of tillage and time of herbicide application in a cool and humid climate. *Weed Res*., 43: 20.

Taylorson, R.B. (1970). Changes in dormancy and viability of weed seeds in soil. *Weed Sci*., 18: 265-269.

Walia, U.S., L.S. Brar and B.K. Dhaliwal (1998). Performance of clodinafop and fenaxapro-p- ethyl for the control *of Phalaris minor* in wheat. *Indian J. Weed Sci*., 30: 48-50.

Young, F.J.L., A.G. Ogg, Jr., R.I. Papendick, D.C. Thill and J.R. Alldredge (1994). Tillage and weed management affect winter wheat yield in an integrated pest management system. *Agron. J*., 86: 147-154.

(*Accepted for publication December 2005*)