International Journal of Science, Environment and Technology, Vol. 3, No 3, 2014, 1260 – 1267
ISSN 2278-3687 (O)

LONG TERM IMPACT OF CHEMICAL FERTILIZERS AND ORGANIC MANURES ON WEED DYNAMICS OF RICE IN RICE-WHEAT SYSTEM

M.K. Walia[1], S.S. Walia[2] and *S.S. Dhaliwal[3]
[1]School of Environment and Natural Resources, The Ohio State University, USA
[2]Department of Agronomy, Punjab Agricultural University, Ludhiana, India
[3]Department of Soil Science, Punjab Agricultural University, Ludhiana, India
E-mail: drdhaliwalss@yahoo.co.in (**Corresponding Author*)

Abstract: A field experiment was conducted (still in progress) to find out the long term effect of integrated nutrient management on weeds dynamics of rice in rice-wheat system in Punjab, India. Among the seven different treatments of chemical fertilizers application in conjunction with different organic sources to substitute 25 to 50 per cent N (FYM, Wheat cut straw or green manuring with *Sesbania aculeata*), the green manuring with *Sesbania aculeata* was found to be more effective in suppressing the weeds and recorded the minimum weed population and weed dry matter compared to other treatments of nutrient substitution through wheat cut straw and farmyard manure. However, the lowest count of weeds m^{-2} and dry matter accumulation by weeds was found in treatment where 100 % recommended dose of inorganic (N, P, K) fertilizers was added to rice and wheat crops. The highest weed count was recorded in treatments where no fertilizer or organic manures as well as suboptimum doses of fertilizers were added which was significantly higher than all other treatments.
Keywords: Crop residues, FYM, green manuring.

INTRODUCTION

Rice-wheat is one of the most predominant cropping systems of the India and contributes about 74 per cent of the total food grains of the country. The cultivation of rice (*Oryza sativa*) has been extended to the non-conventional area apart from the Indo-Gangetic plains because of its better adaptation, favourable government policies and free electricity for tubewells. Rice being an exhaustive crop responds favourably to the chemical fertilizers, however, its productivity has reached at a plateau and staggering around 6 t ha^{-1}. Though the adequate application of chemical fertilizers has continue to increase the yield of paddy but the response in terms of kg grain kg^{-1} of nutrient declined from 15.0 in 1975-76 to 7.6 in 1988-89 (Tiwari , 2002); indicating the sign of distortion in balanced availability of nutrients to the crop. Moreover, the continuous use of high analysis chemical fertilizers and decreased recycling of crop residues and manures induced nutrient deficiencies, particularly of micronutrients and adversely affecting the sustainability of agricultural production, causing

*Received May 13, 2014 * Published June 2, 2014 * www.ijset.net*

environmental pollution with deleterious effect on the physico-chemical properties of soil (Virmani, 1994). Further, due to their continuous cropping, there has been stress on natural resources and total factor productivity has gone down due to decline in soil productivity and competition for different resources (nutrients, moisture, light, space etc.) offered by weeds. These factors have put a question mark on the profitability and sustainability of the system.

Weeds are known to compete with the crop for the same amount of limited environmental resources such as nutrients, water, light and space. Consequently, weeds are capable of reducing yield and impairing crop quality significantly (Juraimi *et al.*, 2011). Ramzan (2003) reported that yield reduction up to 48, 53 and 74% in transplanted, direct seeded flooded and direct seeded aerobic rice due to weeds, respectively. Further, the use of herbicides alone may not provide effective and season-long weed control (Chauhan and Yadav, 2013). Also, because of the increased use of herbicides, the risk of herbicide resistance, and concerns about environmental contamination, there is an interest in integrating herbicide use with cultural weed management approaches (Mahajan and Chauhan, 2013). Khankhane *et a.l,* (2009) reported that the incorporation of rice straw at the rate of 5 t ha^{-1} was the best among the different straw management practices (removal, burning and incorporation) in terms of weed density reduction, improved soil health, increased wheat yield, monetary return and B : C ratio. Besides supplementing the fertilizer need, crop management through residue retaining also had direct effect on the weed density in crop like wheat (Roder *et al.*, 1998, Dastgheib, 2006). Taking into consideration these facts, the experiment was conducted to study the effect of integrated nutrient management (INM) i.e. the combined use of chemical fertilizers with FYM, green manure, crop residues etc. on weed intensity in rice under rice-wheat system.

MATERIALS AND METHODS

The long term experiment on rice-wheat system is in progress at research farm, PAU, Ludhiana under All India Co-ordinated Research Project on Cropping Systems. The soil of the experimental field is Tolewal loamy sand soil with EC 0.32 dS m^{-1}, pH 8.15, low in organic carbon (0.31 %), available N (143 kg ha^{-1}), available P (11.2 kg ha^{-1}) and available K (101 kg ha^{-1}). The experiment consists of fourteen treatments were kept. The details of these fourteen treatments are given in Table 1.

Table 1: Treatment detail (fertilizer and organic manures) in rice-wheat cropping system

Treatment	Rice *(Kharif season)*	Wheat *(Rabi season)*
T_1	control	control
T_2	50% recommended NPK dose through fertilizers	50% recommended NPK
T_3	50% recommended NPK dose through fertilizers	100% recommended NPK
T_4	75% recommended NPK dose through fertilizers	75% recommended NPK
T_5	100% recommended NPK dose through fertilizers	100% recommended NPK
T_6	50% recommended NPK dose through fertilizers + 50% N through FYM	100% recommended NPK
T_7	75% recommended NPK dose through fertilizers + 25% N through FYM	75% recommended NPK
T_8	50% recommended NPK dose through fertilizers + 50% N through wheat cut straw (WCS)	100% recommended NPK
T_9	75% recommended NPK dose through fertilizers + 25% N through wheat cut straw (WCS)	75% recommended NPK
T_{10}	50% recommended NPK dose through fertilizers + 50% N through green manuring (*Sesbania aculeata*)	100% recommended NPK
T_{11}	75% recommended NPK dose through fertilizers + 25% N through green manuring (*Sesbania aculeata*)	75% recommended NPK
T_{12}	100% recommended N dose through fertilizers + 50% N through FYM	100% recommended NPK
T_{13}	$N_{180}P_{30}K_{30}$	$N_{150}P_{60}K_{30}$
T_{14}	100% recommended NPK dose through fertilizers	100% recommended NPK +Cowpea in summer with recommended N

The experiment on rice-wheat system comprises control, recommended level of fertilizers, 50 percent substitution of N through FYM, crop residue and green manure in rice crop while wheat was grown with recommended levels of fertilizers. The FYM was applied on air dry basis (1 per cent N). *Sesbania aculeata* was used as a source of green manure on dry weight basis (2 per cent N). The experiment is laid out in a randomized block design with three replications. Recommended nutrients (viz. N, P and K) for rice were 120 kg, 30 kg and 30 kg ha^{-1}, respectively. Butachlor 50 EC was applied 2 days after transplanting @ 3 litre ha^{-1} by mixing in 150 kg sand. *Dhaincha* (*Sesbania aculeata*) as green manure crop was raised during summer in treatments T_{10} and T_{11} by applying phosphorus dose of succeeding rice. Rice crop (Var. PR 111) was transplanted. Weed count and dry matter of weeds were recorded periodically at 40 days interval after transplanting from each plot using 50 cm x 50 cm quadrat and the total weeds present in the quadrat were counted and expressed as weeds m^{-2}.

Statistical Analysis

To test the significance, the data collected on various aspects of the investigations were statistically analysed with the procedure described by Cochran and Cox (1967). All the comparisons were made at 5 % level of significance.

RESULTS AND DISCUSSION

Effect of different treatments on weed count

The results on the effect of different treatments on weed count and dry matter accumulation by weeds are presented in tables 2 and 3 respectively. The observations were recorded on the periodic weed count. The weed count at various growth stages after rice transplanting (40 DAT, 80 DAT and at harvest) was recorded. The data presented in Table 2, indicated that weed count continued to decrease with time till maturity of crop due to more competition offered by crop to weeds. At 40 DAT, the weed count among different treatments varied from 81.5 to 109.3 weeds m^{-2}. The highest weed count was recorded in treatment T_1 (109.3 weeds m^{-2}), where no fertilizer or organic manures was added which was significantly higher than all other treatments. The increased level of N application to 150 per cent of the recommended N i.e. 180 kg N per ha along with the recommended dose of phosphorus and potassium through inorganic fertilizers in treatment T_{13} or through combined sources of N i.e. 100 per cent of the recommended N through fertilizers along with 50 per cent of the recommended N via FYM in treatment T_{12} resulted in weed count of 96.7 and 97.9 weeds m^{-2}, which was lower by 11.5 and 10.4 per cent over control (T_1), respectively. At 80 DAT of the rice crop, the differences among treatments were significant. The weed population was 40.7 per cent higher in control (T_1) as compared to 100 per cent of the recommended NPK dose through fertilizer in treatment T_5 (60.1 weeds m^{-2}). However, the combined use of inorganic and organic manures to compensate 50 per cent of the recommended N through FYM in treatment T_6, through WCS in treatment T_8 and through GM in treatment T_{10} recorded weed count of 74.3, 71.2 and 67.1 weeds m^{-2}, which was higher by 19.1, 15.6 and 10.4 per cent respectively, over 100 per cent of the recommended NPK dose through fertilizer (T_5) with value of 60.1 weeds m^{-2}.

Table 2: Effect of chemical fertilizers and organic manures on periodic weed count in rice crop

Treatment	Fertilizer use (% of recommended NPK)		Weed count (weeds m^{-2})		
	Rice	Wheat	40 DAT	80 DAT	At harvest
T_1	Control	Control	109.3	84.6	54.4
T_2	50	50	104.5	81.9	52.8
T_3	50	100	99.4	80.2	51.6
T_4	75	75	98.6	78.8	50.3
T_5	100	100	81.5	60.1	38.5
T_6	50+50 % N (FYM)	100	95.1	74.3	47.7
T_7	75+25 % N (FYM)	75	92.8	72.8	46.8
T_8	50+50 % N (WCS)	100	92.6	71.2	45.3
T_9	75+25 % N (WCS)	75	91.5	68.7	44.7
T_{10}	50+50 % N (GM)	100	89.9	67.1	43.8
T_{11}	75+25 % N (GM)	75	88.7	66.5	43.1
T_{12}	100+50 % N (FYM)	100	97.9	76.5	48.9
T_{13}	$N_{180}P_{30}K_{30}$	$N_{150}P_{60}K_{30}$	96.7	76.0	48.4
T_{14}	100	100 +	83.2	63.4	40.1
	CD (p=0.05)	Cowpea	1.81	0.52	0.43

The weed count was less with WCS as compared to FYM as residue might have suppressed the emergence of weed seeds. Similar results have been reported by Chauhan and Yadav (2013) that crop residue in a normal amount can effectively suppress the emergence of small-seeded weed species but for large-seeded species, a high amount of residue may be needed to substantially affect seedling emergence.

At harvesting, application of 50 per cent recommended NPK in treatment T_2 and 75 per cent of the recommended NPK in treatment T_4 recorded 52.8 and 50.3 weeds m^{-2} which was 37.5 and 30.6 per cent higher over treatment T_5 (38.5 weeds m^{-2}), where 100 per cent of the recommended NPK dose through fertilizer was applied. Further, compensating 25 per cent of the recommended N through FYM, WCS and GM in treatments $T_{7,}$ T_9 and $T_{11,}$ respectively along with 75 per cent of the recommended NPK dose through fertilizer showed weed count of 46.8, 44.7 and 43.1 weeds m^{-2} which was higher by 21.5, 16.1 and 11.9 per cent over treatment T_5.

Effect of different treatments on dry matter accumulation (DMA)

The dry matter accumulation by weeds at various growth stages after rice transplanting (40 DAT, 80 DAT and at harvest) was recorded. The data presented in Table 3, indicated that dry matter accumulation by weeds continued to decrease with time till maturity of crop due to more competition offered by crop to weeds. At 40 DAT, the DMA (dry matter accumulation) among different treatments varied from 4.08 to 5.46 q ha^{-1}. The highest DMA was recorded in treatment T_1 (5.46 q ha^{-1}), where no fertilizer or organic manures was added which was significantly higher than all other treatments.

Table 3: Periodic dry matter accumulation by weeds as influenced by chemical fertilizers and organic manures

Treatment	Fertilizer use (% of recommended NPK)		DMA (q ha^{-1})		
	Rice	Wheat	40 DAT	80 DAT	At harvest
T_1	Control	Control	5.46	7.58	4.84
T_2	50	50	5.23	7.08	4.75
T_3	50	100	4.97	6.94	4.59
T_4	75	75	4.93	6.82	4.57
T_5	100	100	4.08	5.20	3.43
T_6	50+50 % N (FYM)	100	4.76	6.43	4.25
T_7	75+25 % N (FYM)	75	4.64	6.30	4.09
T_8	50+50 % N (WCS)	100	4.63	6.16	4.03
T_9	75+25 % N (WCS)	75	4.58	5.94	4.01
T_{10}	50+50 % N (GM)	100	4.50	5.80	3.90
T_{11}	75+25 % N (GM)	75	4.43	5.75	3.65
T_{12}	100+50 % N	100	4.90	6.62	4.35
T_{13}	(FYM)	$N_{150}P_{60}K_{30}$	4.84	6.57	4.31
T_{14}	$N_{180}P_{30}K_{30}$	100 +	4.16	5.48	3.57
	100	Cowpea			

The increased level of N application to 150 per cent of the recommended N i.e. 180 kg N per ha along with the recommended dose of phosphorus and potassium through inorganic fertilizers in treatment T_{13} or through combined sources of N i.e. 100 per cent of the recommended N through fertilizers along with 50 per cent of the recommended N via FYM in treatment T_{12} resulted in DMA by weeds of 4.84 and 4.90 q ha^{-1}. At 80 DAT of the rice crop, DMA by weeds was 45.8 per cent higher in control (T_1) as compared to 100 per cent of the recommended NPK dose through fertilizer in treatment T_5 (5.20 q ha^{-1}). However, the combined use of inorganic and organic manures to compensate 50 per cent of the

recommended N through FYM in treatment T_6, through WCS in treatment T_8 and through GM in treatment T_{10} recorded DMA of 6.43, 6.16 and 5.80 q ha^{-1}, which was higher by 23.7, 18.5 and 11.5 per cent respectively, over 100 per cent of the recommended NPK dose through fertilizer (T_5) with value of 5.20 q ha^{-1}. However, the DMA by weeds was less in plots where wheat cut straw was applied as compared to FYM application. Khankhane *et al.,* (2009) also observed that incorporation of rice straw in wheat crop leads to weed suppression, improved the soil health and increased the wheat yield. Further, the DMA by weeds was less in plots where green manuring was done as compared to plots where FYM as well as WCS was applied. Weerakoon *et al*., (1992) reported that in situ green manuring interrupts the production of weed seeds and propagules.

At harvesting, application of 50 per cent recommended NPK in treatment T_2 and 75 per cent of the recommended NPK in treatment T4 recorded 4.75 and 4.57 q ha^{-1} of dry matter by weeds which was 38.5 and 33.2 per cent higher over treatment T_5 (3.43 q ha^{-1}), where 100 per cent of the recommended NPK dose through fertilizer was applied. Further, compensating 25 per cent of the recommended N through FYM, WCS and GM in treatments T_7, T_9 and T_{11}, respectively along with 75 per cent of the recommended NPK dose through fertilizer showed DMA of 4.09, 4.01 and 3.65 q ha^{-1} which was higher by 19.2, 16.9 and 6.4 per cent over treatment T_5. Further, the rice crop sown without or suboptimum application of fertilizers alone accumulated more dry matter of weeds as compared to application of fertilizers at the recommended rate in treatment T_5. However, the crop sown with the application of 50 per cent N through FYM, WCS and GM along with inorganic fertilizers in treatments T_6, T_8 and T_{10}, respectively, showed significantly lower dry matter of weeds as compared to control and suboptimum application of fertilizers alone. However, its values are higher as compared to application of fertilizers at the recommended rate in treatment T_5.

CONCLUSIONS

The results of this study indicate that weed count and dry matter accumulation by weeds continued to decrease with time till maturity of crop due to more competition offered by crop to weeds. However, the application of 100 per cent of the recommended NPK dose through fertilizers recorded the lowest weed count as well as dry matter accumulation by weeds as compared to other treatments of sub optimum, supra optimum and fertilizer aplication in conjunction with FYM, WCS and green manuring.

REFERENCES

[1] Chauhan B.S. and Yadav A. (2013) Weed management approaches for dry-seeded rice in India: a review. *Indian Journal of Weed Science* 45(1): 1–6.

[2] Cochran W.G. and Cox G.M. (1967) Experimental Designs. John Willey and Sons, Inc., New York.

[3] Dastgheib F. (2006) Relative importance of crop seed, manure and irrigation water as source of weed infestation. *Weed Research* 29(2):113-116.

[4] Juraimi A.S., Muhammad Saiful A.H., Uddin M.K., Rahim A.A., Azmi M. (2011) Diversity of weeds under different water regimes in irrigated direct seeded rice. Aust J Crop Sci. 5:595-604.

[5] Khankhane P.J., Barman K.K. and Varshney Jay G. (2009) Effect of rice residue management practices on weed density, wheat productivity and soil fertility in a swell-shrink soil. *Indian Journal of Weed Science* 41(1&2): 41-45.

[6] Mahajan G. and Chauhan B.S. (2013) The role of cultivars in managing weeds in dry-seeded rice production systems. *Crop Protection* 49: 52–57.

[7] Ramzan M. (2003) Evaluation of various planting methods in rice-wheat cropping systems, Punjab, Pakistan. Rice Crop Report 2003-2004: 4-5.

[8] Roder W., Keoboulapha B., Phengehanh S., Prot J.C. and Matias D. (1998) Effect of residue management and fallow length on weeds and rice yields. *Weed Research Oxford* 38 (3): 167-174.

[9] Tiwari K.N. (2002) Nutrient management for sustainable agriculture. *J Indian Soc Soil Sci* 50: 374-97.

[10] Virmani S.M. (1994) UNCED agenda-21: The new challenges for soils research. *J Indian Soc Soil Sci* 42: 516-24.

[11] Weerakoon W.L., Seneviratne G., Silva M. and Seneviratne A.M. (1992) Evaluation of *Sesbania speciosa* as a green manure for lowland rice in the dry zone, Sri Lanka. *Plant and Soil* 145: 131-139.