WEED DYNAMICS AND YIELD OF WHEAT IN LONG TERM SOIL FERTILITY EXPERIMENT UNDER RICE-RICE-WHEAT CROPPING SYSTEM

N. Khatri[1], B. P. Pandey[1], M. Yadav[2], B. P. Chaurasia[3], M. Bista[4] and B. Kunwar[5]

ABSTRACT

Weed dynamics and yield and yield parameters of wheat was studied in long-term soil fertility experiment underrice-rice-wheat system during winter season of 2018-19. The experiment was laid out in randomized complete block design with nine treatments replicated three times. Treatments were applied as: T1- no nutrients added, T2- N added; T3- N and P added; T4- N and K added; T5- N_2:P_2O_5:K_2O added at recommended rate for all crops. Similarly, T6- only N added in rice and N_2:P_2O_5:K_2O in wheat at recommended rate; T7- half N; T8- half NP of recommended rate for both crops; and T9- farmyard manure @10 t ha^{-1} for all crops in rotation. The results revealed that the use of Farm Yard Manure @ 10 t ha^{-1} gave significantly higher yield of 2393 kg ha^{-1} followed by recommended chemical fertilizer dose of 100:40:30 N:P_2O_5:K_20 kg ha^{-1} of 2383 kg ha^{-1}. Considerably, lower grain yield was obtained from treatments that did not receive phosphorus. Similarly, application of FYM @10 t ha^{-1} followed by recommended fertilizer dose recorded higher weed density and dry weed weight with compared to any of N,P_2O_5 and K_2O or all nutrient omitted treatments.

Keywords: FYM, inorganic fertilizer, weed, wheat, yield

INTRODUCTION

Rice and wheat are the major crops in Nepal. Suitable rice-wheat based cropping system has to be evaluated, to assess the stability in production (Kumpawat, 2001). Soil fertility and plant nutrient management are key issues to be addressed to understand the reasons for declining crop yields. Intensive agriculture, involving exhaustive high yielding varieties of rice and other crops, has led to heavy withdrawal of nutrients from the soil; imbalanced and discriminate use of chemical fertilizers has resulted in deterioration of soil health (John et al., 2001). The productivity of land under such a system is unlikely to be sustained unless nutrient deficiencies or

1 Scientist, National Wheat Research Program, Bhairahawa, Rupandehi, Nepal
Corresponding author: Email: narayan.iaas068@gmail.com, Mobile number: +977 9858050471

2 Senior Scientist, National Wheat Research Program, Bhairahawa, Rupandehi, Nepal

3 Technical Assistant, National Wheat Research Program, Bhairahawa, Rupandehi, Nepal

4 Technical Assistant, Regional Agriculture Research Station, Lumle, Kaski, Nepal

5 Plant Protection Officer, Ministry of Agriculture and Livestock Development, Nepal.

imbalances are identified and corrected promptly. Example can be cited of zinc deficiency in rice and boron in wheat. Additionally, there is a risk of environmental hazards due to their imbalanced application resulting into declined soil fertility, crop productivity and environmental instability. On the other hand, inadequate plant nutrients supply has been considered as one of the factors of lower crop productivity. The long-term effects of using organic fertilizers are of great significance in relation to sustained crop yield, maintain soil fertility and protect the environment as well. Balanced nutrition of plant is a mean to improve crop yield. For a resource poor country like Nepal, the use of fertilizer alone may not be a viable solution to sustain the crop yield and maintain soil health under rice-wheat system, the predominant cropping system. Use of organic manures including farmyard manure, goat manure and poultry litter use for crop production might be a substitute of the chemical fertilizers (Sanchez-Monedero et al., 2004). Use of local agricultural bio resources as a substitute of fertilizers is now in great demand because they are more cost-effective and environment friendly (Bhattacharya et al., 2008). Crop production practices such as tillage, weed management and fertilizer application, influence weeds in agriculture (Barberi et al., 1997).

Weeds are omnipresent and compete with crops for nutrients, space, water and light. Weed density, type of the weeds, their persistence and crop management practices determine the magnitude of yield losses. Weed infestation is the major bottle neck to higher wheat productivity and accounts for more than 48% loss of potential wheat yield (Khan and Haq, 2002). Fertilizer use whether it is organic, or inorganic has definite influence on weed emergence, weed growth, weed dynamics, and weed dispersion attributes. Application of organic manure can increase weed population (Arif et al., 2013), as most of the time incorporation of organic manure such as FYM and poultry manure served as weeds seeds store bank (Baig et al.,2001). Unless controlled properly, weeds are major users of nutrients applied to crops. Crop management through residue retaining also had direct effect on the weed density in crop like wheat (Roder et al., 1998, Dastgheib, 2006). Therefore, the objective of this study was to determine the effects of organic manure and inorganic fertilizer levels on yield and weed diversity in wheat under rice-rice-wheat cropping system.The long-term experiment was initiated in 1978/79 at NWRP, Bhairahawa and it has been continued up to now. The major objective was to study the long-term application of mineral fertilizer or manure on crop yields and soil properties.

METHODOLOGY

The experiment was conducted in the experimental site of the Research Farm of at National Wheat Research Program (NWRP), Bhairahawa, Rupandehi, Nepal. The layout of the plots was kept undisturbed for growing all early rice, normal season rice and wheat. The treatments for wheat were applied as: T1-

no nutrients added, T2- N added; T3- N and P added; T4- N and K added; T5- N_2:P_2O_5:K_2O added at recommended rate for all crops. Similarly, T6- only N added in rice and N_2:P_2O_5:K_2O in wheat at recommended rate; T7- half N; T8- half NP of recommended rate for both crops; and T9- farmyard manure @10 t ha^{-1} for all crops in rotation (Table 1). The experiment was laid out in randomized complete block design as described by Gomez and Gomez (1984) with nine treatments, which were replicated three times. The plot size was 4 x 3 m^2. Wheat was sown in rows of 25 cm apart and continuous line sowing. Nitrogen, phosphorus and potash were supplied through Urea, Di-ammonium phosphate and muriate of potash, respectively. Full dose of phosphorus and potash and half dose of nitrogen were applied at the time of sowing. Farm-yard manure was applied at 10 days before seeding. Remaining 50% nitrogen was top dressed at 21-25 days after seeding in wheat. Yield and yield attributing parameters; tiller number m^{-2}, number of grains $panicle^{-1}$, panicle length, plant height, 1000-grain weight, grain yield and straw yield were recorded.

Data on only weeds flora and yield of wheat in 2018-19 wheat season is presented in this paper. Observations on weed density were recorded using quadrate method as described by Pound and Clements (1998). Data on different weed species and weed dry weight were recorded at 30, 60 and 90 days after sowing (DAS). These data were subjected to square root transformation before analysis. Weeds inside the quadrate measuring 0.5 m x 0.5 m were identified and counted. The weeds were then uprooted carefully. The uprooted weeds were washed thoroughly in clean water and dried first in the sun for two days and thereafter in a hot air oven for 72 hours at 72°C. The weight of the dried sample was taken, and the average data were expressed as weed dry weight (gm/0.25 m^2). The analysis of variance of all recorded parameters was analyzed by using GEN STAT Software.

Table 1: Treatments on wheat and rice crops

SN	Treatment (Wheat)	Treatment (Rice)	Symbol
1	0: 0:0 N:P_2O_5:K_2O kg ha^{-1}	0: 0:0 N:P_2O_5:K_2O kg ha^{-1}	T1
2	100:0:0 N:P_2O_5:K_2O kg ha^{-1}	100:0:0 N:P_2O_5:K_2O kg ha^{-1}	T2
3	100:40:0 N:P_2O_5:K_2O kg ha^{-1}	100:30:0 N:P_2O_5:K_2O kg ha^{-1}	T3
4	100:0:30 N:P_2O_5:K_2O kg ha^{-1}	100:0:30 N:P_2O_5:K_2O kg ha^{-1}	T4
5	100:40:30 N:P_2O_5:K_2O kg ha^{-1}	100:30:30 N:P_2O_5:K_2O kg ha^{-1}	T5
6	100:40:30 N:P_2O_5:K_2O kg ha^{-1}	100:0:0 N:P_2O_5:K_2O kg ha^{-1}	T6
7	50:0:0 N:P_2O_5:K_2O kg ha^{-1} + 30 cm rice stubble incorporation	50:0:0 N:P_2O_5:K_2O kg ha^{-1} + 30 cm rice stubble incorporation	T7
8	50:20:0 N:P_2O_5:K_2O kg ha^{-1} + 30 cm rice stubble incorporation	50:20:0 N:P_2O_5:K_2O kg ha^{-1} + 30 cm rice stubble incorporation	T8
9	F Y M 10 t ha^{-1}	F Y M 10 t ha^{-1}	T9

RESULTS AND DISCUSSION

WEED SPECIES

The recorded weed species during the experiment are presented below (Table 2). A total of 8 weed species from 6 different families were recorded during the field experiment. The observed weed species were *Chenopodium album, Cynodondaactylon, Anagalis arvensis, Solanum nigrum, Medicago denticulate, Vicia sativa, Lathyrus vestitus and Cyperusrotundus*. Among different weed floras, broad leaved weed species were found to be most dominant followed by sedge and grass.

Table 2: Observed weed species in experimental field

Weed Species	Family Name	Leaf Morphology
Chenopodium album	Amaranthaceae	Broad leaf
Cynodondactylon	Poaceae	Grass
Anagalis arvensis	Primulaceae	Broad leaf
Solanum nigrum	Solanaceae	Broad leaf
Medicago denticulate	Fabaceae	Broad leaf
Vicia sativa	Fabaceae	Broad leaf
Lathyrus vestitus	Fabaceae	Broad leaf
Cyperusrotandus	Cyperaceae	Sedge

WEED DENSITY

The result revealed that different treatments had significant effect on weed density (Table 3). Among different treatments, application of FYM 10 t ha^{-1} (T9) recorded significantly highest weed density in all date followed by application of recommended dose of fertilizer @100:40:30 kg ha^{-1} $N:P_2O_5:K_2O$ (T5), T6, T3, T4 and T2. Our results are in line with the findings of Ali et al. (2011) who also reported that weeds density m^{-2} in maize was higher in FYM incorporated plots as compared to control. Application of organic manure can increase weed population (Arif et al., 2013) as most of the time incorporation of organic manure such as FYM and poultry manure served as weeds seeds store bank (Baig et al., 2001). Similarly, Elmetwally et al. (2010) reported that application of higher level of nitrogen fertilizer markedly increased weed density at harvest in barley crop.

In treatment FYM @10 t ha^{-1}(T9), weed density of 9.64, 10.36, and 10.08 /0.25 m^{-2} recorded at 30, 60 and 90 DAS respectively. Lowest weed density was observed on those treatments where either in nitrogen, phosphorus and potash missing or in all nutrient missing treatments (T7, T8, T1, T2 and T3). Moreover, many weeds are high N or P consumers (Qasem, 1992; Blackshaw et al., 2003); thus, the growth of many weed species is enhanced by higher soil

N or P levels. Weed population were found highest at 60 DAS followed by 30 DAS and lowest was recorded at 90 DAS. This might be due to some weed species emerged earlier and some species emerged later, i.e. different weed species have different growth habit.

Table 3: Effect of different combination of inorganic fertilizers and farm-yard manure on weed density during 2018-19

Treatment	Weed density/0.25 m^2		
	30 DAS	60 DAS	90 DAS
T1	5.48 (33.3)	6.48 (44.7)	5.31 (29)
T2	7.45 (65.3)	7.72 (62.7)	5.44 (31)
T3	8.68 (75.7)	7.96 (66.7)	5.47 (32)
T4	7.94 (66)	7.25 (54.3)	6.51 (43.3)
T5	9.55 (91.7)	10.14 (103)	9.89 (98)
T6	9.49 (90)	10.07 (101.3)	9.76 (95.3)
T7	5.18 (31.7)	6.25 (39.3)	5.48 (31.3)
T8	5.23 (28.3)	7.2 (54.7)	5.86 (36.3)
T9	9.64 (93)	10.36 (107.3)	10.08 (102.7)
F-test	*	*	**
LSD (0.05 %)	3.11	2.51	2.14
CV %	23.5	17.8	17.4

** and ** denotes significant at 1 % and 5 % level of significance respectively*
Data in parentheses indicates original value.

WEED DRY WEIGHT

There was significant difference in weed dry weight during 30 DAS and 90 DAS however not during 60 DAS (Table 4). Weed dry weight was found highest in treatment T9 (FYM @ 10 t ha^{-1}) followed by T5 (100:40:30 kg ha^{-1} $N:P_2O_5:K_2O$). Similar results were reported by Jama et al. (1997) who reported that application of organic manures resulted in higher weeds biomass and weeds density. Balanced fertilization also recorded higher weed dry weight in all date. In 30 DAS, higher weed dry weight of 2.45 gm was obtained in T9 followed by 2.17 gm in T5 and the trend was found similar in 60 and 90 DAS. Lowest weed dry weight was recorded in any of N, P_2O_5 and K_2O nutrient omission or whole nutrient omission treatments.

Table 4: Effect of different combination of inorganic fertilizers and farm-yard manure on weed dry weight during 2018-19

Treatment	Weed dry weight (gm/0.25 m^2)		
	30 DAS	60 DAS	90 DAS
T1	1.37 (1.93)	2.10 (4.63)	1.22 (1.6)
T2	2.04 (4.5)	2.22 (6.4)	1.91 (3.67)
T3	2.15 (4.6)	2.31 (7.2)	1.83 (3.83)
T4	2.05 (4.5)	2.08 (4.33)	1.89 (4.33)
T5	2.17 (4.8)	2.53 (6.97)	2.88 (8.33)
T6	2.12 (4.5)	2.51(6.3)	2.83 (8.00)
T7	0.55 (0.35)	1.27 (1.7)	1.54 (3.3)
T8	0.91 (0.9)	1.66 (3.4)	1.79 (3.87)
T9	2.45 (6.27)	2.61 (7.1)	2.91(8.5)
F-test	**	ns	*
LSD (0.05 %)	0.77	-	0.93
CV %	25.2	34.2	25.6

***, * and ns denote significant at 1 % and 5% level of significance and non-significant respectively, Data in parentheses indicates original value.*

EFFECT ON YIELD PARAMETERS

There was a significant difference in plant height, thousand grain weight and grain yield of wheat in various treatments during the experiment (Table 5). The average plant height ranged from 74 to 96 cm depending upon the treatment. Tallest plant height of 96 cm recorded from treatment T9 (FYM 10 ton ha^{-1}) followed by T6 (100:40:30 $N:P_2O_5:K_2O$ kg ha^{-1}) where as shortest plant height was found in T2, T7 and T4 respectively. The effect of different treatments on number of tillers m^{-2} and number of grains per spike was found non-significant. However, highest number of tillers m-2 and number of grains per spike was found highest of 248 and 43 in application of FYM @ 10 t ha^{-1} respectively. Similarly, 1000 grain weight was also found significantly higher (43.7 gram) in application of FYM @ 10 t ha^{-1} (T9) followed by application of $N:P_2O_5:K_2O$ @100:40:30 kg ha^{-1} (T6). The observed lower thousand grain weight was recorded in potassium omission treatment (100:40:0 $N:P_2O_5:K_2O$ (kg ha^{-1}) (T3). The grain yield was found significantly higher (2393 kg ha^{-1}) with the use of FYM @10 tha^{-1} (T9) followed by recommended fertilizer dose (T5) of 2383 kg ha^{-1}. Significantly lowest grain yield of wheat was observed in phosphorus omitted plots (T2, T4 and T7). These results indicated that severe deficiency of potassium and phosphorus was observed in wheat and plays a major role in increasing the wheat yield. The highest grain yield on T9 treatment may be mainly attributed to an increased thousand grain weight, number of grains per spike and number of tiller m^{-2}.

Table 5: Yield and yield attributes of wheat under different treatment

Treatment	Plant height (cm)	Number of tillers m^{-2}	Number of grains $spike^{-1}$	1000 grain wt (gm)	Grain yield (kg ha^{-1})
T1	83	147	41	38.2	617
T2	74	202	46	30.7	505
T3	80	198	31	23.7	790
T4	77	165	35	37.3	557
T5	90	198	39	38.5	2383
T6	93	186	42	39.1	2178
T7	76	193	29	36.5	499
T8	87	181	38	36.6	1379
T9	96	248	43	43.7	2393
F-test	**	ns	ns	**	**
LSD (0.05 %)	7.5	-	-	3.8	334.5
CV %	5.1	22.3	16.7	6.1	15.4

*** denotes significant at 1 % level of significance and ns denotes non-significant*

CONCLUSION

The results of this study indicate that there was very low wheat grain yield in all phosphorus missing treatments (T1, T2, T4, and T 7). This shows Phosphorus is one of the most limiting factors in wheat crop. Application of FYM @ 10 t ha^{-1} in long run or recommended dose of chemical fertilizer increased the wheat grain yield and weed population as well. Hence, balanced dose of organic manure or recommended dose of inorganic fertilizer along with effective weed management practices should be applied to increase the wheat grain yield.

ACKNOWLEDGEMENT

The authors are thankful to Nepal Agricultural Research Council (NARC), Nepal for providing financial support to conduct research. Authors are also highly indebted to technical staffs and daily wage workers of National Wheat Research Program, Bhairahawa for their kind support and help.

REFERENCES

Arif, M., Ali, K., Haq, M.S. and Khan, Z. 2013. Biochar, FYM and nitrogen increases weed Infestation in wheat. Pakistan Journal of Weed Science Research, 19(4):411-418.

Baig, M.K., Nanjappa, H. and Ramachandrappa, B.K. 2001. Weed dynamics due to difference organic sources of nutrients and their effect on growth and yield of maize (*Zea mays L.)*. Research on Crops, 2:283-288.

Barberi, P., Silvestri, N. and Bonari, E. 1997. Weed communities of winter wheat as influenced by input level and rotation. Weed Research, 37:301-313.

Bhattacharya, R., Kundu, S., Prakash, V. and Gupta, H.S. 2008. Sustainability under combined application of mineral and organic fertilizers in a rain-fed soybean-wheat system of the Indian Himalayas. European Journal of Agronomy, 28:33–46.

Blackshaw, R.E., Brandt, R.N., Janzen, H.H., Entz, T., Grant, C.A. and Derksen, D.A. 2003.Differential response of weed species to added nitrogen. Weed Science, 51:532-539.

Dastgheib, F. 2006. Relative importance of crop seed, manure and irrigation water as source of weed infestation. Weed Research, 29:113-116.

Elmetwlly, I.M., Abdel, E.S.M. and Tagour, R.M.H. 2010. Nitrogen fertilizer levels and some weed control treatments effects on barley and associated weeds. Agricultural and Biological Journal, 5(1): 992-1000.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for agricultural research, 2nd Edition, John Willy and Sons, New York.680 p.

Jama, B., Swinkles, R.A. and Buresh, R.J. 1997. Agronomic and economic evaluation of organic and inorganic phosphorus in western Kenya. Agronomy Journal, 89: 597-604.

John, P.S., George, M. and Jacob, R. 2001.Nutrient mining in agro–climatic zones of Kerala. Fertilizer News, pp. 45-57.

Khan, M., and Haq, N. 2002. Wheat crop yield loss assessment due to weeds. SarhadJournal of Agriculture, 18: 449-453.

Kumpawat, B.S. 2001. Production potential and economics of different crop sequences. Indian Journal of Agronomy, 46(3): 421-424.

Pound, R. and Clements, P.E. 1998. A method of determining the abundance of secondary Weeds species. Minn. Bot. Studies., 2: 9p.

Qasem, J.R. 1992. Nutrient accumulation by weeds and their associated vegetable crops. Journal of Horticulture Science, 67: 189-195.

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, 38:167-174.

Sanchez-Monedero, M., Mondini, C., Nobili, M., Leita, L. and Roig, A. 2004. Land application of biosolids. Soil response to different stabilization degree of the treated organic matter. Waste Management, 24:325–532.