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EFFECT OF WEEDS AND SOIL AMENDMENTS ON N, P AND K CONTENTS OF RICE

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Abstract

A field experiment was conducted to assess the nitrogen (N), phosphorus (P) and potassium (K) contents of rice *(Oryza sativa* L.) as influenced by soil amendments and four common weeds namely *Echinochloa colonum* (L.) Link, *Cyperus rotundus* L., *Marsilea minuta* L. and *Paspalum paspaloides* (Michx.) Scribn. The field soil was amended either with recommended (N) or half dose (½ N) of N-fertilizer as urea along with recommended dose of P_2O_5 and K_2O or with farmyard manure (FYM) @ 15 tons ha^{-1}. N, P and K contents and grain yield were greatly affected by weed competition and soil amendments. The highest N and P contents were recorded in weed free control in recommended dosage of N. N contents in rice were significantly reduced by all the weeds in ½N dose, and by *M. minuta* and mixed weeds in recommended dose of N. In FYM, all the weeds except *E. colonum* significantly reduced N contents in rice. P contents were only significantly reduced in ½N dose due to mixed weeds. K contents were significantly enhanced due to presence of weeds in ½N, and were insignificantly affected in FYM amendment. Grain yield was invariably reduced due to weed competition in all the three soil amendments. Mixed weeds proved more damaging than individual weeds. The highest yield losses of 37-75% due to weeds were recorded in FYM followed by 12-56% in ½N dose and 12-40% in recommended N dose treatment. There was a positive correlation between grain yield, and shoot N and P contents, in all the three soil amendments. Correlation between grain yield and shoot K contents was negative in ½N dose and FYM amendments.

Key words: NPK contents, Rice, Soil amendments, Weeds.

Introduction

Agricultural losses due to weed competition worldwide are estimated to be several times greater than losses caused by even combined effect of any phytopathogen (Pourreza *et al*., 2010). Management options are mostly based on weed communities compositions, while alteration in such compositions is indicative of potential weed management problems (Derksen *et al*., 1995). Employing nutrients to get rid of weed in return of high crop yield is a common practice worldwide. These nutrients likely boost all crops and weeds species overcoming competition effects. However, two schools of thought are still working based on either negative impact of weed on uptake of nutrients by plants or vice versa (Wortmna *et al*., 2011).

Considering the fact that weeds are superior nutrient consumers (Hans & Johnson, 2002), hence exhaust soil nutrients level by improving their own growth, while leaving deleterious effect on crop of interest (Blackshaw *et al*., 2004). However, different level of nutrients in soil provides variation in growth rate and resource acquisitions in weed species to variant external nutrient provision such as fertilizer level, application timing, and methods (Evan, 2001; Hans & Johnson, 2002; Harbur & Owen, 2004). So far, it has been suggested that amendment of N fertilizers to wild oat-infested wheat fields increases wild oat competitions and decreased yield (Pourreza *et al*., 2010). Jalali *et al*., (2011) reported that interference by weeds resulted in immediate and pronounced effects on yield potential and N uptake by weeds. They further stated that application of higher N levels beyond the crop requirement can increase the risk of N loss due to weed uptake and environmental contamination. Arif *et al*., (2013) determined that fertilization of soil with biochar, farmyard manure and nitrogen levels considerably increased weed infestation in wheat crop. However, second school of thought agreed with little effect on weed flora, density and competition due to N level or application methods (Blackshaw *et al*., 2004; Blackshaw, 2005). Abouziena *et al*., (2007) observed that more N favoured growth and yield of maize more than weeds. Saravanane *et al*., (2008) observed that utilization of certain weeds like *Chromolaena odorata* increased N level in soil and total N, P and K uptake by potato. Nagar *et al.,* (2009) found that balanced fertilization with NPK significantly improved weed dry weight and nutrient uptake by weeds, but simultaneously enhanced nutrient uptake and growth in coriander. Umm-e-Kalsoom e*t al*., (2012) documented that fertilization of soil with NPK promoted the growth of both maize crop and weed.

In rice cropping system, the effect of weeds in depleting soil nutrient level is more important because of considerable significance of rice in Asia with ever demanding crop worldwide (Pingali *et al*., 1997). Weed competition is a major drawback while declines grain yield up to 60% (Rabbani *et al*., 2011) by up taking 8 times more nutrients (N, P and K) than the crop (Singh *et al*., 2002). Sudhalakshmi *et al*., (2005) reported that nutrient uptake by weeds was 30 kg N, 10 kg P and 17 kg K per hectare in transplanted rice in clay loam soil. Puniya *et al*., (2007) noticed that the highest loss of nutrients (N 42.07, P 10 and K 21.80 kg ha^{-1}) occurred due to more density and dry weight of weeds in transplanted rice during kharif in silt loam soil. Khan *et al*., (2012) also reported that N increased the biomass of crop and weed. Therefore, it is imperative to assess the influence of different N fertilizer rates on growth, yield and uptake of nutrient by rice plant under weed stress. Keeping these points in view, current investigation was conducted to assess the influence of four common weeds namely *E. colonum, C. rotundus, M. minuta* and *P. paspaloides*, N-management and farmyard manure on N, P and K contents and yield of rice.

Materials and Methods

A field experiment was laid out in split plot design keeping soil amendments in main plots and weeds in subplots. There were three soil amendments viz. farmyard manure (FYM) @ 15 tons ha^{-1}, nitrogen @ 120 kg ha^{-1} (recommended dose) and @ 60 kg ha^{-1} (half dose) in the form of urea. Both the nitrogen amended soils also received recommended doses of P_2O_5 @ 75 kg ha^{-1} and K_2O @ 60 kg ha^{-1} as triple super phosphate and potassium sulphate, respectively. The whole P_2O_5 and K_2O, and half N were applied as basal at the time of rice transplantation. Remaining N was top dressed prior to flowering. A basal dose of ¼ NPK was also applied in the FYM amended plots at the time of rice transplantation. Each treatment was replicated thrice.

One month old rice seedlings were transplanted in the subplots keeping inter and intra row spacing of 20 cm. Fifteen days old seedlings of four rice weeds viz. *C. rotundus*, *E. colonum*, *P. paspaloides,* and *M. minuta* were transplanted in subplots 15 days after transplantation of rice, with 1:1 ratio of weed and rice plants. A mixed weeds treatment was also laid out similarly. A weed free treatment in each of the three soil amendments served as control. Irrigation was done by tube well water. Decisions to irrigate were made on estimates of need based on visible soil moisture, plant growth stage, and weather reports for rainfall probabilities. Plants were harvested at maturity. Samples of six plants, selected at random, and were uprooted from each of the treatment subplot. Quantitative data regarding the grain yield was recorded and averaged to per plant basis.

Percentage losses in grain yield due to various weeds were also calculated. The plants were analyzed for total nitrogen using Kjeldahl method as described by Winkleman ***et al*.,** (1990). For phosphorous plant samples were digested with nitric acid and perchloric acid (2:1) as described by Winkleman ***et al*.,** (1990). The absorbance was recorded on spectrophotometer. The digested extract used for plant phosphorus estimation was also analyzed for potassium. Potassium concentration in the digests was determined by using flame photometer.

All the data were analyzed by Duncan's Multiple Range Test at 5% level of significance (Steel & Torrie, 1980).

Results and Discussion

Effect of weeds and soil amendments on N contents of rice: In half N-dose treatment the highest and significantly greater N contents were observed in control. Although all the weeds significantly reduced N contents, however, N contents in rice showed different response to different weeds. The effect of *E. colonum* and *C. rotundus* was comparatively less severe than *M. minuta* and *P. paspaloides.* Maximum reduction in N uptake was recorded in mixed weeds (Table 1).

In full dose of N treatment, the highest N contents were recorded in control as in ½ N dose treatment. However, in this soil amendment system, N contents response of rice to competition of various weeds was different as compared to ½ N dose treatment. Here the negative impact of *E. colonum, C. rotundus* and *P. paspalum* on N contents was insignificant while that of *M. minuta* and mixed weeds was significant ($p \leq 0.05$). Maximum reduction in N contents was recorded in *M. minuta* (Table 1).

As in N-fertilizer amended soils, N contents in FYM amendment was also the highest in control. All the weeds except *E. colonum* significantly reduced N contents in rice (Table 1). This study reveals that N contents in rice varies with amount and source of N. The highest N contents were observed in recommended dose of N fertilizers followed by ½ N dose and FYM, respectively (Priyanka *et al*., 2013). N contents in rice were adversely affected by different weeds. Different weeds not only have different impact on N economy in rice but they also differ in their adverse effects in different soil amendment systems. *M. minuta, P. paspaloides* and mixed weeds seem to be more harmful in N deficient soils as compared to *E. colonum* and *C. rotundus. M. minuta* also proved to be the most notorious to reduce N contents in rice in the presence of recommended dose of N fertilizer. In FYM amended soil, difference in N contents by rice among the various weed treatment was less pronounced as compared to N-fertilizer amendments. Reduction in N uptake due to weeds have also been reported earlier in rice (Puniya *et al*., 2007) and wheat (Naeem & Shad, 1995).

Table 1. Effect of weeds and soil amendments on shoot N contents.

Treatments	½ N dose	Full N dose	Farmyard manure
Weed free	2.30 a	2.65 a	2.3 a
Echinochloa colonum	2.01 bc	2.40 ab	2.2 ab
Cyperus rotundus	2.08 b	2.44 ab	2.08 cd
Marsilia minuta	1.89 cd	1.91 c	2.18 bc
Paspalum paspaloides	1.97 b-d	2.28 a-c	2.12 b-d
Mixed weeds	1.84 d	2.16 bc	2.06 c

Values with different letters in a column show significant difference ($p \leq 0.05$) as determined by DMR Test.

Table 2. Effect of weeds and soil amendments on shoot P contents.

Treatments	½ N dose	Full N dose	Farmyard manure
Weed free	0.235 a	0.248 a	0.233 a
Echinochloa colonum	0.234 a	0.241 a	0.241 a
Cyperus rotundus	0.233 a	0.245 a	0.233 a
Marsilia minuta	0.237 a	0.246 a	0.232 a
Paspalum paspaloides	0.233 a	0.235 a	0.235 a
Mixed weeds	0.213 b	0.241 a	0.234 a

Values with different letters in a column show significant difference ($p \leq 0.05$) as determined by DMR Test.

Table 3. Effects of weeds and soil amendments on shoots K content.

Treatments	½ N dose	Full N dose	Farmyard manure
Weed free	2.08 d	2.47 a	2.13 ab
Echinochloa colonum	2.50 a	2.31 ab	2.30 a
Cyperus rotundus	2.23 bc	2.19 bc	2.30 a
Marsilia minuta	2.41 a	2.19 bc	1.96 b
Paspalum paspaloides	2.28 b	2.05 c	2.25 a
Mixed weeds	2.14 cd	2.20 bc	2.23 a

Values with different letters in a column show significant difference ($p \leq 0.05$) as determined by DMR Test.

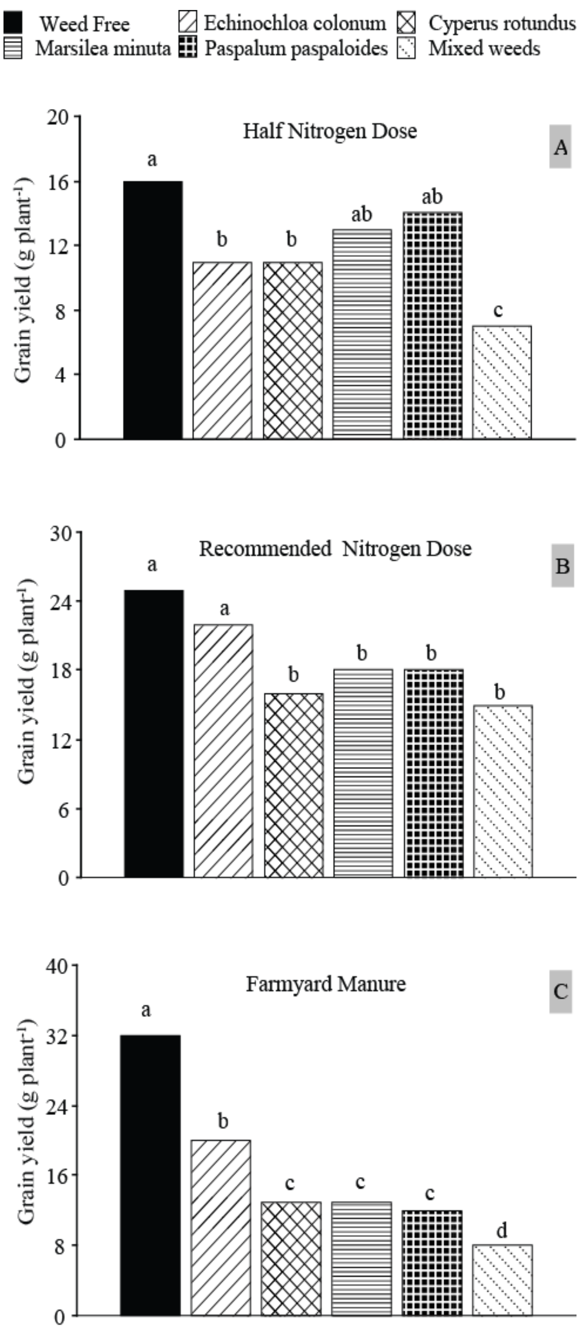

Fig. 1. Effect of weeds and soil amendments on grain yield in rice. Bars with different letters at their top show significant difference at 5% level, as determined by DMR Test.

Effect of weeds and soil amendments on P contents in rice: Unlike N contents, P contents in rice showed less variable response to different weed competitions. In ½ N dose treatment, all the weeds except mixed had an insignificant effect on P contents of rice. In full N dose and FYM treatments all the weed treatments had insignificant impact on P contents in rice (Table 2). These results indicate that rice weeds generally do not compete as much with the crop for P as for N. In contrast, Holm (1971) reported that corn weeds contained 1-6 times more P as compared to the corn crop. Similarly, Naeem & Shad (1995) found greater absorption of P by some weeds as compared to wheat crop.

Effect of weeds and soil amendments on K contents in rice: K contents were significantly ($p \leq 0.05$) increased due to presence of all the weeds except mixed in ½ N dose treatment. Maximum increase was observed in *E. colonum* followed by *M. minuta* (Table 3). In full N dose treatment, K contents were reduced due to all the weeds. The effect was significant ($p \leq 0.05$) due to all weeds except *E. colonum* (Table 3). It seems probable that weeds favoured uptake of K when N was deficient in the soil. In FYM amended soil, *M. minuta* reduced while other weeds enhanced K contents in rice. The effect was, however, insignificant statistically (Table 3). Variable absorption of K in the presence of full and half dose of N reveal that K uptake in rice is controlled by N concentration in the soil. Furthermore, weeds change the absorption pattern of K differently in different N levels in the soil.

Effect of weeds and soil amendments on yield of rice: The highest grain yield in weed free control was recorded in FYM followed by full and half dose of N, respectively. All the weeds had adverse impact on yield in all the three soil amendments. However, yield response in rice to weed competition varied with weed species and soil amendment (Fig. l). In ½ N dose treatment *E. colonum, C. rotundus* and mixed weeds significantly reduced yield in rice. The highest reduction of 55% was recorded due to mixed weeds. In full N dose treatment, all the weeds except *E. colonum* significantly reduced grain yield (Fig. l). Mixed weeds and *C. rotundus* were proved more damaging, causing 45% and 43% yield losses, respectively, followed by *M. minuta* and *P. paspaloides* causing 30% yield losses. In FYM amended soil, adverse impact of the weeds on yield was more severe as compared to N-fertilized treatments. In this soil amendment system all the weeds significantly reduced grain yield. Yield losses ranging from 25% in *E. colonum* to 70% in mixed weeds were recorded under this soil amendment system (Fig. 1).

The study of correlation coefficient reveals that grain yield was positively correlated with N and P contents in all the three types of soil amendments (Table 4). Correlation was significant ($p \leq 0.05$) between grain yield and shoot P in ½ N treatment and highly significant ($p \leq 0.01$) between grain yield and N in farmyard manure amended soil (Table 4). It indicates that grain yield was increased by increased uptake of N and P. Thus the reduced grain yield in the presence of weeds may be at least partially, attributed to reduced uptake of N and P due to weeds competition for these nutrients. Correlation between grain yield and K content was negative and insignificant in ½ N and farmyard manure amended soils but significantly positive ($p \leq 0.05$) in full N dose treatment.

Table 4. Correlation between grain yield of rice and NPK contents of shoots.

	½ N dose	Full N dose	Farmyard manure
Grain yield vs. N	0.64	0.55	0.93**
Grain yield vs. P	0.77*	0.33	0.20
Grain yield vs. K	-0.03	0.82*	-0.15

*, **, Significant at 5% and 1% level of significance, respectively.

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