EFFECT OF N-FERTILIZER AND FARMYARD MANURE ON WEED COMPETITION IN RICE

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Abstract

A field study was conducted to evaluate the effect of nitrogen (N) rate (recommended and half dose) and farmyard manure (FYM) on weed competition in rice (Oryza saliva) var. Super Basmati. Four frequently occurring weeds viz., Echinochloa colonum, Cyperus rotundus, Marsilea minuta and Paspalum paspaloides were grown in rice in a 1:1 ratio of weed and rice plants. The highest vegetative growth and grain yield in weed free control plots was observed in FYM followed by full N and half N dose of fertilizers, respectively. Maximum losses in plant biomass and grain yield due to weed competition were recorded in FYM. Percentage losses in half and full dose of N due to different weeds were close to one another. Mixed weeds in all the three types of amendments generally were more damaging as compared to either of the four weed species. Weed biomass was generally greater in FYM and full N dose as compared to half N dose.

Key words: Farmyard manure, fertilizer, nitrogen, rice, weeds.

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INTRODUCTION

Rice is an important cash crop of Pakistan. It is cultivated on an area of 2789200 hectares with a total production of 6798100tonnes (Pakistan Bureau of Statistics, 2013-2014). Basmati rice contributes the main share in the rice export. Weed infestation in rice field poses a recurrent and ubiquitous threat to agricultural productivity in Pakistan (Mann *et al*., 2007; Akbar *et al*., 2011; Khaliq *et al*., 2012). Apart from competition for soil moisture, nutrients, space and sun light with crop, weeds also affect growth, yield and quality of crop plant as a result of production of allelochemicals that escape into the environment (Roy *et al*., 2006; Siddiqui *et al*., 2010).Number of cultural and manual weed control strategies has been opted (Abouziena *et al*., 2008; Juraimi *et al*., 2013) with inherited drawbacks including reliance of manual

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weeding on weather conditions, time and labor consuming on larger area (Chaudhry, 1994; Khaliq *et al*., 2011). One very effective weed management option is incorporation of different level of nitrogen (N) rates to soil that resulted in healthy crop with aggressive crop competition against weed (Khan *et al*., 2012). Different selection pressures have led to distinct physiological traits pertaining to nutrient acquisition and growth, which influences the competitive balance between crops and weeds (Ditomaso, 1995). Blackshaw *et al*. (2003) stated that besides reducing availability of N to crop, weed grow intensively under increasing rate of N. In another study, application of high rate of N fertilizer resulted in increased competition of weeds in corn field due to an increase in leaf area index of weeds than corn (Barker *et al*., 2006). Sweeney *et al*. (2008) reported the influence of N on weed emergence is dependent on the weed species, seed source, and environmental conditions. Loss in wheat yield and increased in weed competition was recorded with increase in rate of N fertilizer (Pourreza *et al*., 2010). Wortman *et al*. (2011) reported a shift in competitive balance for certain crop-weed combinations due to incorporation of N fertilizer. Chamanabad *et al*. (2011) documented that 100 kg N ha^{-1} could be helpful in managing weeds in potato filed. Azadbakht *et al*. (2012) showed that increasing rate of N fertilizer increased weed competition with sunflower and N @ 100 kg ha^{-1} positively favour sunflower biological yield and decreased weeds. Nelson *et al.* (2013) documented selection of proper source of N fertilizer considerably affected the biomass of weed and increased corn yield.

The objective of the present study was to determine the influence of farmyard manure, and full and half doses of N in the form of urea application, on competition between rice var. Super Basmati and four frequently occurring weeds viz. *Echinochloa colonum, Paspalum paspaloides, Cyperus rotundus* and *Marsilea minuta.*

MATERIALS AND METHODS

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) at 15 tons per ha, nitrogen at 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 at 75 kg ha^{-1} and K_2O at60 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.

One month old rice seedlings were transplanted in the sub plots 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 after 90, 120 and 150 days of sowing. At each of the three harvest stages, samples of six plants, selected at random, were uprooted from each of the treatment subplot. Quantitative data regarding the shoot and root growth were recorded and averaged to per plant basis. At physiological maturity grain yield per plant and 100 grain weight were also recorded. Harvest index was calculated as economic yield expressed in percentage over biological yield. Percentage losses in root, shoot and grain yield due to various weeds were also calculated.

The data were analyzed for simple statistics including means standard error, standard deviation, variance and correlation coefficients. Effect of individual weed species on various quantitative traits of rice regarding root and shoot growth, and grain yield was analyzed by applying Duncan's Multiple Range Test (Steel and Torrie, 1980) at 5% level of significance.

RESULTS AND DISCUSSION

Basic Statistics

Data regarding the basic statistics of averaged values of different traits of rice, grown in half and full dose of N fertilizers and in farmyard manure (FYM) amended soils, is presented in Table-1 to Table-3. The highest values of percentage variance and high range for all the traits were observed in FYM followed by half and full dose of N fertilizer, respectively. It indicates that rice shows maximum variable response to different weeds in FYM amended soil followed by half dose of N fertilizers. These results also reveal that some weeds of rice exhibit their maximum suppressive ability in FYM amended soil followed by half dose of N fertilizers. The maximum values for different traits in the three types of soil amendments, represent that the growth and yield potential of this rice genotype can be better exploited in FYM amendment under weed free system.

Effect of weeds and soil amendments on shoot growth in rice

Data regarding the effect of individual weeds on shoot growth in rice under the three soil amendment systems are presented in Fig. 1-3. Shoot length was not much affected due to weed competition in ½N treatment. A significant reduction was observed in mixed weed treatment at all the growth stages and due to *C. rotundus* at 120 days growth stage. Effect of different weeds on shoot length in full N dose was more pronounced where shoot length was significantly reduced due to competition of all the weeds except *E. colonum.* The most severe effect of weeds was observed in FYM amended soil where all the weeds significantly reduced shoot length in rice. The effect of *M. minuta* and mixed weeds was more severe than rest of the weed species (Fig. 1).

The effect of weeds on tillering was variable at different growth stages in half and full N dose treatments. The effect was more severe at 90 days growth stage as compared to succeeding growth stages and more so due to *C. rotundus* and mixed weeds as compared to other weeds (Fig. 2). Similar to shoot length, tillering was also considerably affected by weed competition in FYM amended soil where all the weeds reduced tillering invariably and significantly. Like N amended soils, *C. rotundus* and mixed weeds were relatively more damaging than rest of the weed species in FYM amendment (Fig. 2). The effect of different weeds on shoot dry biomass was similar to that of tillering (Fig. 3). All the weeds caused higher percentage reduction in shoot biomass in FYM as compared to NPK applied soils. Maximum reduction of 70% was recorded due to *C. rotundus* competition in FYM. The same weed species also caused 58% reduction in shoot biomass in full N treatment. Losses due to mixed weeds, however, were the greatest followed by *C. rotundus* in half dose of N leading to 50% and 42% reduction in shoot biomass, respectively.

Effect of weeds and soil amendments on root growth of rice

All the weeds reduced root biomass in rice in all the three soil amendment systems. However, a variable response to weed species, soil amendment and growth stage of the rice plants was evident. In half N treatment, a significant reduction was observed at 90 and 120 days growth stage by all the weeds. However, at 150 days growth stage, the effect was only significant in mixed weeds treatment (Fig. 4). In full N treatment, the effect of weeds was inconsistent at different growth stages, except mixed weeds that caused consistent and significant negative impact on root biomass through out the growth period. Like shoot biomass, root biomass was also severely declined by all the weeds in FYM amended soil. The reduction in root biomass ranged from 55-75% in FYM as compared to 10-45% in half N and 25-40% in full N dose (Fig. 4).

Effect of weeds and soil amendments on yield of rice

The lowest grain yield in rice was recorded in half N dose. Significant yield losses were evidenced due to *E. colonum, C. rotundus* and mixed weeds infestations in this dose. In full N dose, the yield was better in all the weed treatments as compared to their corresponding treatments in half N dose. All the weeds except *E. colonum* caused a significant reduction in yield in this soil amendment system (Fig. 5A).

Significant yield losses occurred with all weeds in FYM amendment, ranging from 22-70% as compared to 32-50% in half N and 23-40% in full N treatments. It reveals that higher N fertilizer rate reduced the weed competition probably as a result of more competitive crop growth (Jornsgard *et al*., 1996; Saeed *et al*., 2010; Ashrafi *et al*., 2010). In contrast, other studies have reported that increased N rates increased the competitive ability of some weeds (Cook and Clarke, 1997; Acciaresi *et al*., 2001). The present study further indicates that FYM amendment increases weed competition resulting in heavy yield losses.

There was not any significant difference in 100 grain weight among the various weed treatments in full N amendment. In half N amendment, 100 grain weight was significantly reduced due to *M. minuta* and mixed weed treatments while in FYM amendment all the weeds except *E. colonum* significantly reduced 100-grain weight (Fig. 5B).

Effect of soil amendments on weed biomass

The weed species invariably exhibited inconsistent growth pattern at various growth stages. However, in general weed growth was better in FYM and full N dose as compared to half N dose (Fig. 6). Acciaresi *et al.* (2003) have reported that N rate, placement and source can influence the response of weed species. Similarly, Wortman *et al*. (2011) and Mohammadi *et al*. (2012) observed an increase in weed biomass due to increased rate of N. In contrast, other workers have reported a declining trend in weed density with increased rate of N attributed to more competitive crop growth (Ross andVan Acker, 2005; Abouziena *et al*., 2008). Jalali *et al.* (2012), however, reported that N rate did not affect weed density in early stage of plant growth but weed biomass increased at later stages of growth. Likewise, Aminpanah (2013) reported that N application did not affect competition between rice and weed. There was a negative correlation between weed biomass and different growth and yield traits in rice at different growth stages in half N dose treatment, except tillers per plant, shoot dry weight and 100 seed weight at 150 days growth stage (Table-4). Keeping in view the losses under this N management system, the negative correlations clearly indicate that weeds grew at the expense of rice crop. It seems probable that under this N management system, weeds benefited because of less competitive crop growth. In full N and FYM, there was a positive correlation between weed biomass and various shoot growth parameters in rice at 90 days growth stage, indicating that both weeds and rice crop benefited equally from nutrients under these soil amendment systems. Root growth was positively and highly significantly ($P \leq 0.01$) correlated with weed biomass at this growth stage in FYM (Table-4). At later growth stages, however, the weed biomass was negatively correlated with various growth parameters. Grain yield in both full N and FYM was positively correlated with weed biomass. Correlation was highly significant ($P \leq 0.01$) in FYM (Table-4).

CONCLUSION

The present study concludes that the genotypic potential of this rice cultivar can be better exploited in FYM amended soil in weed free fields. The recommended dose of N proved to be the best agricultural practice for better rice yield under weed infestation. There is need to extend this experiment by using different N rate and sources. Such studies would be helpful in evaluating the nutrient conditions best suited to the rice growth and yield under heavy weed infestation.

Table-1. Basic statistics for the effect of different weeds on various quantitative traits in rice in soil amended with N, P and ½ N.

Traits	Max	Min	Mean±SE	α	α^2	α^2(%)
			90 days after sowing			
Shoot length (cm)	75	60	69±2	5	25	68
Tillers per plant	11	6	9±1	2.5	6.2	68
Shoot dry weight (g)	15	5	11.6±1.7	4.3	18	157
Root dry weight (g)	7.5	2	7±0.8	2	4	70
			120 days after sowing			
Shoot length (cm)	90	75	85.5±2.3	5.5	30	36
Tillers per plant	13	8	11±0.75	2	4	31
Shoot dry weight (g)	35	15	25.5±3	7.3	53.3	209
Root dry weight (g)	6.5	2.5	4.5±0.7	1.7	2.9	64
			150 days after sowing			
Shoot length (cm)	90	77	86±2	5	25	29
Tillers per plant	11	7	9.5±1.8	1.64	2.7	28
Shoot dry weight (g)	14	6	10.3±1	2.73	7.5	72
Root dry weight (g)	4	2	3.1±0.29	0.71	0.5	16
Grain yield per plant(g)	16	7	12±1.6	3.09	9.5	79
100-grain weight (g)	1.9	1.9	1.9±0.001	0.01	0.0001	0.005

SE = Standard Error, α = Standard deviation, α^2 = Variance
α^2 (%) Variance expressed as percentage of mean

Table-2. Basic statistics for the effect of different weeds on various quantitative traits in rice in soil amended with N, P and N.

Traits	Max	Min	Mean±SE	A	α^2	α^2 (%)
			90 days after sowing			
Shoot length (cm)	88	78	82±1.6	3.8	15	18
Tillers per plant	14	8	11±0.86	2	4	40
Shoot dry weight (g)	21	12	17±1.6	4	16	94
Root dry weight (g)	9	3	6.3±0.8	2	4	64
			120 days after sowing			
Shoot length (cm)	98	47	92.5±1.63	4	16	17
Tillers per plant	15	11	13±0.6	1.5	2.25	17
Shoot dry weight (g)	45	33	39±1.76	4.3	18	47
Root dry weight (g)	9	4.7	7±0.61	1.5	2.25	32
			150 days after sowing			
Shoot length (cm)	103	87	93.5±2.4	6	36	38
Tillers per plant	15	9	12.3±0.9	2.16	4.7	38
Shoot dry weight (g)	20	13	15.8±1.2	3	9	57
Root dry weight (g)	7	3	5.1±0.6	1.4	2	38
Grain yield per plant (g)	25	15	19±1.5	3.8	14.4	76
100-grain weight (g)	2	1.5	1.98±0.08	0.08	0.0064	0.32

SE = Standard Error, α = Standard deviation, α^2 = Variance
α^2 (%) Variance expressed as percentage of mean

Table-3. Basic statistics for the effect of different weeds on various quantitative traits in rice in soil amended with farmyard manure

Traits	Max	Min	Mean±SE	A	$α^2$	$α^2$ (%)
			90 days after sowing			
Shoot length (cm)	94	68	76±4	10	96	126
Tillers per plant	16	7	11±1.3	3	10	91
Shoot dry weight (g)	28	7	15±3	7	51	34.
Root dry weight (g)	11	2	4.5±1.3	3.3	11	240
			120 days after sowing			
Shoot length (cm)	105	71	89±3.4	8.4	71	80
Tillers per plant	19	9	13±1.5	3.7	14	105
Shoot dry weight (g)	53	17	31±13	13	169	536
Root dry weight (g)	10	3	6±12	3	9	154
			150 days after sowing			
Shoot length (cm)	114	83	94±5	13	144	152
Tillers per plant	21	7	13±2	5	25	177
Shoot dry weight (g)	35	11	18±3.6	9	81	438
Root dry weight (g)	7	2	1.4±0.8	2	4	107
Grain yield plant^{-1}(g)	32	8	16±3.5	8.6	74	454
100-grain weight (g)	2	1.7	2±0.07	0.2	0.04	2

SE = Standard Error, α = Standard deviation, $α^2$= Variance
$α^2$ (%) Variance expressed as percentage of mean

Table-4. Correlation between weeds dry biomass and different growth and yield parameters of rice in different soil amendment systems.

Rice	Weeds dry biomass		
	Half N	Recommended N	Farmyard manure
90 Days After Sowing			
Shoot length	-0.18	0.59	0.47
Tillers per plant	-0.68	0.10	0.29
Shoot dry weight	-0.55	0.56	0.07
Root dry weight	-0.21	-0.24	0.91**
120 Days After Sowing			
Shoot length	-0.67	-0.41	-0.53
Tillers per plant	-0.41	0.27	-0.57
Shoot dry weight	-0.23	-0.26	-0.68
Root dry weight	-0.56	-0.40	-0.91**
150 Days After Sowing			
Shoot length	-0.29	-0.3	-0.89**
Tillers per plant	-0.30	-0.07	-0.56
Shoot dry weight	0.25	-0.58	-0.46
Root dry weight	-0.17	0.03	-0.03
Grain yield per plant	-0.48	0.57	-0.83**
100-seeds weight	0.25	0.04	-0.39
Harvest index	-0.77*	0.02	-0.56

* Significant at 5% level, ** Significant at 1% level

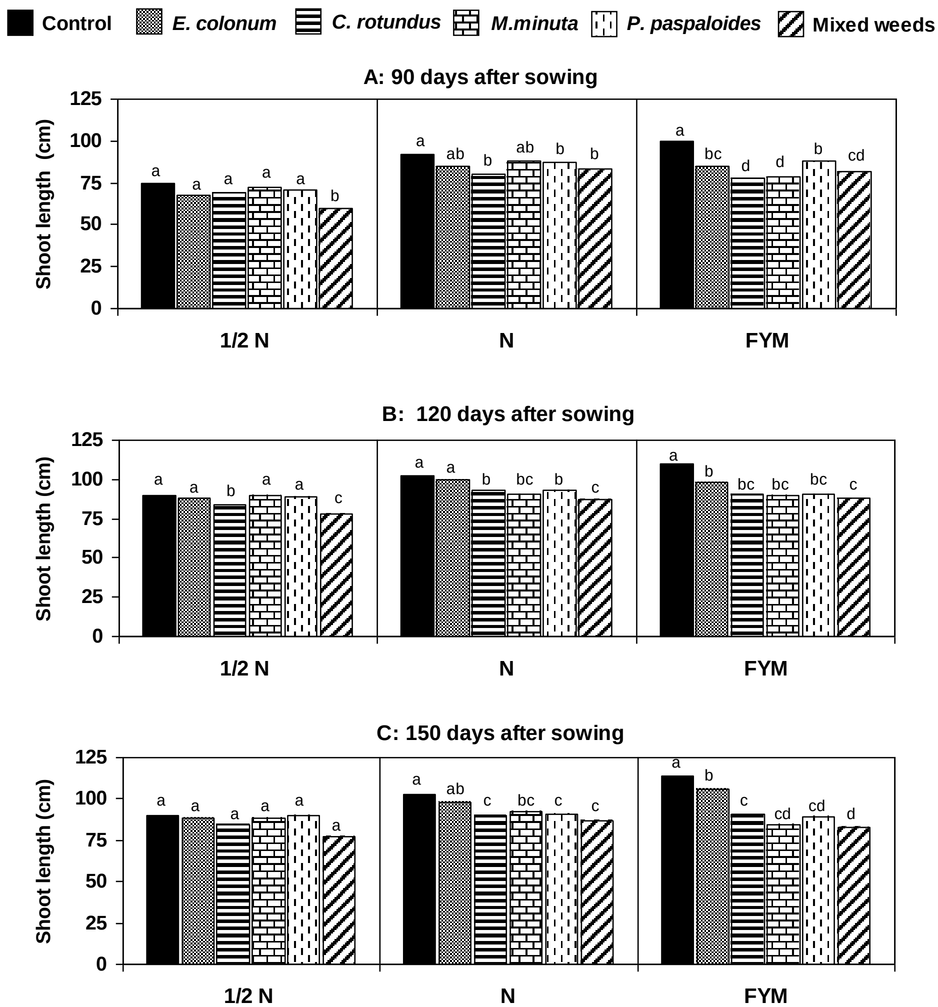

Figure 1. Effect of weeds and soil amendments on shoot length of rice. Bars with different letters show significant difference at P≤0.05, separately for each soil amendment, as determined by Duncan's Multiple Range Test. C: Control (weed free); EC: *Echinochloa colonum*; CR: *Cyperus rotundus*; MM: *Marsilia minuta*; PP: *Paspalum paspaloides*; MW: Mixed weeds. 1/2 N: Half dose of nitrogen fertilizer; N: Recommended dose of nitrogen fertilizer; FYM: Farmyard manure.

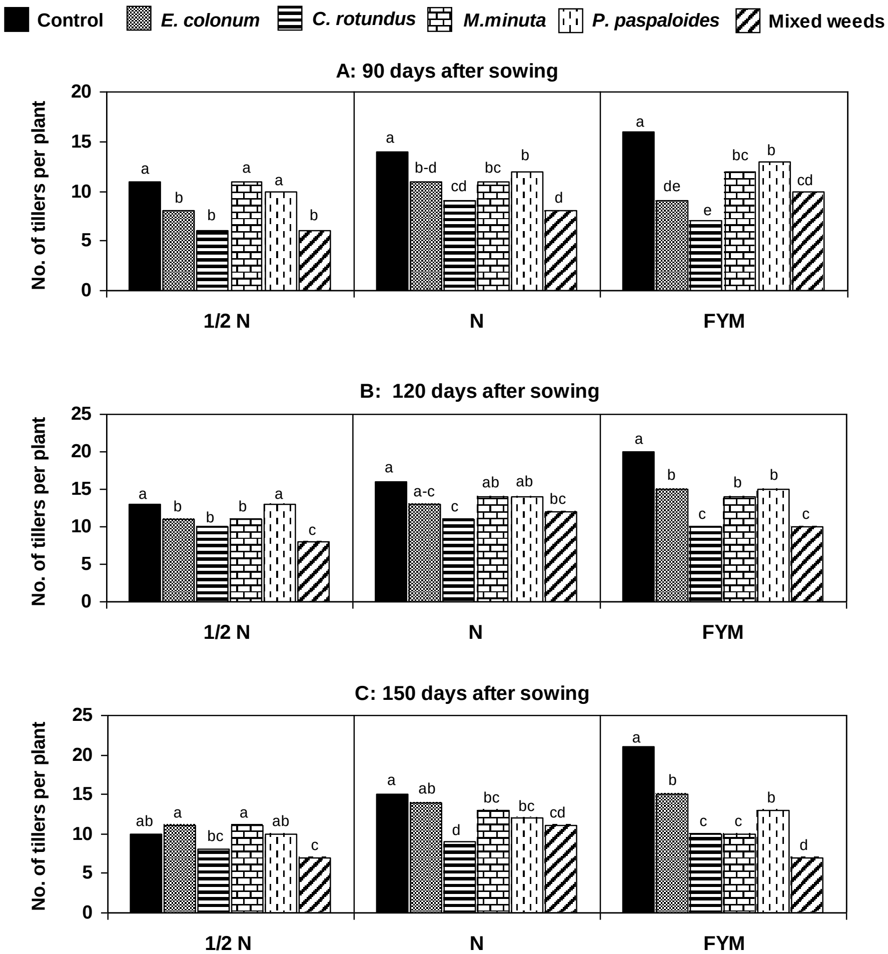

Figure 2. Effect of weeds and soil amendments on tillering in rice. Bars with different letters show significant difference at $P \le 0.05$, separately for each soil amendment, as determined by Duncan's Multiple Range Test. C: Control (weed free); EC: *Echinochloa colonum*; CR: *Cyperus rotundus*; MM: *Marsilia minuta*; PP: *Paspalum paspaloides*; MW: Mixed weeds. 1/2 N: Half dose of nitrogen fertilizer; N: Recommended dose of nitrogen fertilizer; FYM: Farmyard manure.

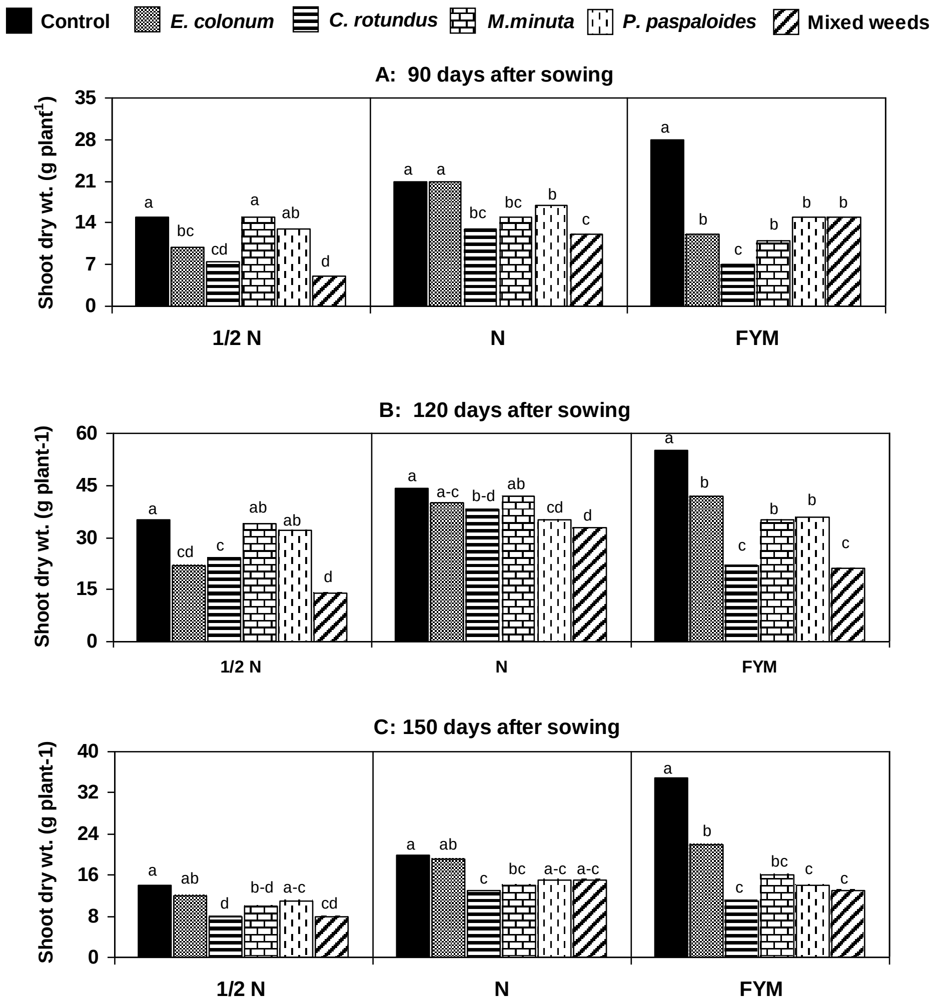

Figure 3. Effect of weeds and soil amendments on shoot dry weight of rice. Bars with different letters show significant difference at P≤0.05, separately for each soil amendment, as determined by Duncan's Multiple Range Test. C: Control (weed free); EC: *Echinochloa colonum*; CR: *Cyperus rotundus*; MM: *Marsilia minuta*; PP: *Paspalum paspaloides*; MW: Mixed weeds. 1/2 N: Half dose of nitrogen fertilizer; N: Recommended dose of nitrogen fertilizer; FYM: Farmyard manure.

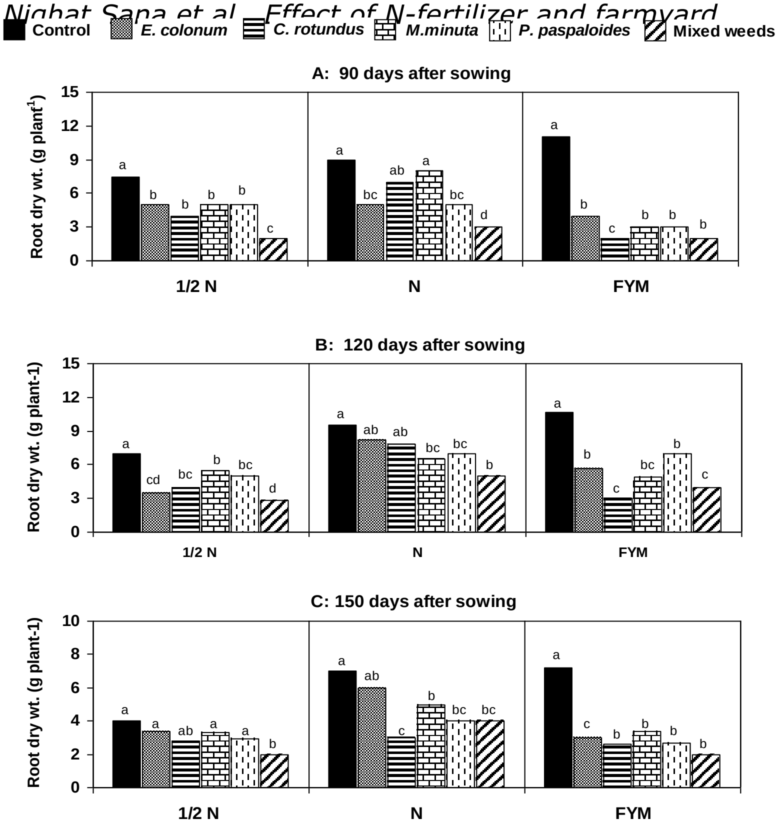

Figure 4. Effect of weeds and soil amendments on root dry weight of rice.

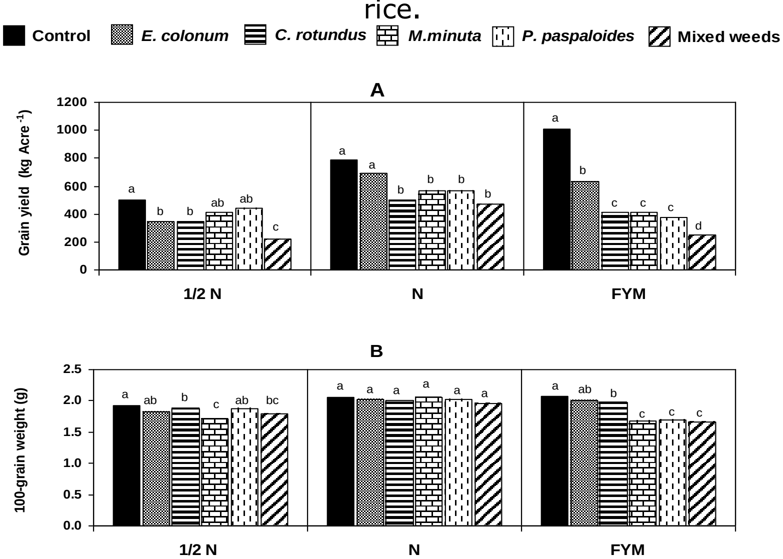

Figure 5. Effect of weeds and soil amendments on yield of rice.

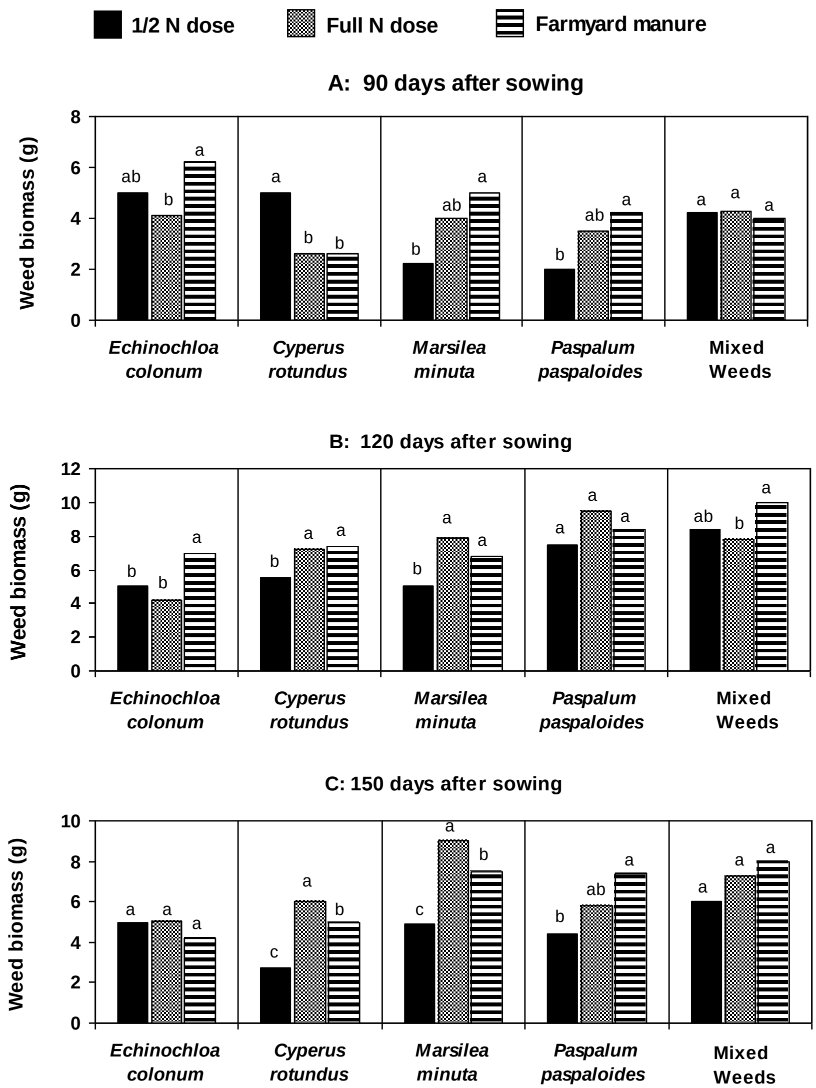

Figure 6. Dry biomass of weeds of rice in soils amended with recommended (N) and half (1/2N) doses of nitrogen fertilizers, and farmyard manure (FYM). Bars with different letters show significant difference at P≤0.05, separately for each weed, as determined by Duncan's Multiple Range Test.

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