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OPTIMIZING RICE PRODUCTION IN SINDH: UNLEASHING THE POWER OF PLANT NUTRIENTS AND WEED CONTROL FOR SUPERIOR QUALITY HARVESTS OF PADDY RICE (*ORYZA SATIVA* L.)

REEMA VISTRO[1], QAMARUDDIN JOGI[1], MUHAMMAD NAWAZ KANDHRO[1], NAIMATULLAH LAGHARI[2] AND GHULAM MURTAZA JAMRO[3]

[1]*Department of Agronomy, Faculty of Crop Production, Sindh Agriculture University, Tandojam Pakistan*
[2]*Department of Farm Power & Machinery, Faculty of Agricultural Engineering, Sindh Agriculture University Tandojam Pakistan*
[3]*Department of Soil Science, Faculty of Crop Production, Sindh Agriculture University, Tandojam Pakistan*
Corresponding author's email: reema.vistro@yahoo.com

Abstract

The current field experiments were conducted during two successive years throughout Kharif, 2017 and 2018 at Students' Experimental Research Farm, Department of Agronomy, Sindh Agriculture University, Tandojam, Pakistan. The rice variety Shandar 45 days old seedlings were transplanted on 15 May in both years. The experiment was conducted in 20 m^2 (5m × 4m) plots, with a 40cm border, following randomized complete block design. The results showed significant effects on weed, agronomic and physiological traits. Minimum interactive values for weed density was observed with F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1} × W_1 = (No weeding), minimum fresh biomass of weed (g m^{-2}) and weed dry biomass (g m^{-2}) was observed with F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1} × W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1}. However, minimum weed control (0.00 %) was found with F_1 = No fertilizer (Control) × W_1 = Weedy check (No weeding). Maximum interactive values were noted for panicle length, kernel $panicle^{-1}$, seed index (1000 kernel wt. g), kernel yield (t ha^{-1}) and protein (%) with F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1} × W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT). The maximum kernel wt. $panicle^{-1}$ (g) was recorded with F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1} × W_3 = Sorghum water extract at 25 L ha^{-1} (10 DAT). However, maximum crop growth rate (gm^{-2} day^{-1}) was recorded with F_4 = NPK + B 160+80+80+1.0 kg ha^{-1} × W_3 = Sorghum water extract at 25 L ha^{-1} (10 DAT). The study revealed research areas to establish adequate management practices through different levels of nutrients and weed control for the enhancement of quality paddy rice production.

Key words: Integrated management, Rice, Nutrition, Weed, Quality.

Introduction

Rice (*Oryza sativa* L.) is one of the most important grain crops that is consumed by more than three and half billion peoples throughout the world (Anon., 2016). Due to its aroma, flavor, and cooking quality, fragment/ aromatic rice is favored by most of the human population. However, most fragment rice cultivars have modest yield and are quickly affected by environmental conditions (Paul *et al*., 2021). Rice contributes one-fifth of the global dietary energy supply, and several countries of Asia and the Pacific (17), North and South America (9), and Africa (8) mostly rely on rice for their staple food (Gadal *et al*., 2019). Hence, it shows that paddy (rice) is the most vital staple crop for food and nutrition safety worldwide. Nevertheless, it is important food as well as value added crop in Pakistan. Whereas, known to be the second major staple food crop following wheat and next largest exportable produce after cotton. It contributes about 3.1 percent of value added and overall, 0.6 per cent in GDP (Ali, 2020).

Among the many agronomic performances, good nutrient management may boost the yield of aromaticrice not only by providing the needed quantity of nutrients, but also by preserving the soil's health and product quality (Paul *et al*., 2021). For boosting up the yield, nitrogenous, phosphoric and potassium (NPK) fertilizers have a very important role when used in suitable amounts (Cheema *et al*., 2021). Addition of 200 kg ha^{-1} N helps to increase the number of tillers, plant height, leaves per plant, spike length, grains per spike, fresh and dry weight, and biological yield, respectively. However, it has been predicted that due to excess use of N and P, in future there will be issue of their universal deficiency, especially for P followed by zinc. Zinc is important in many aspects of life (Camilla *et al*., 2022). The adoption of a modern agriculture system based on high-analysis synthetic fertilizers exacerbated issues with micronutrient shortages such as boron (Subhadeep *et al*., 2022).

The zinc and boron deficiency is high in Pakistan soil. Wetland rice soils, light finished soils, and calcareous soils are mostly found zinc deficient (Islam *et al*., 2017). Zinc mostly has a vital position in line of auxin; dehydrogenase catalysts enactment and keep up with the ribosomal properties (Obata *et al*., 2015). The significance of boron in enhanving crop yields has been reported in the literature (Shah *et al*., 2016). Moreover, for a particular crop, the recommended doses of fertilizers ought to be found on series of field experiments. The outcomes can be beneficial after determining the rate of utilizing financial factors and conditions to estimate the ideal dosages of manures (Rai, 2019). Consequently, maintaining proper micronutrient levels in the soil is crucial not only for meeting plant demands and preserving agricultural output, but also for preventing nutrient build-up (Majeed *et al*., 2022).

Weed management strategies in Pakistan are applied mainly in irrigated areas, ignoring the rain fed regions, which eventually results in low production. Since in rain fed areas, rice crops already suffer due to stress conditions, the occurrence of weeds could accelerate the loss of moisture from the soil (Mandal *et al.*, 2016). Therefore, it is essential that weeds be controlled to keep away from unnecessary utilization of crop resources. For directly cultivated paddy (rice), it is compulsory to maintain the fields free from weeds in the initial 30 days (Bisht & Ramana, 2017). Considering these considerable facts allied to previous findings, the present study was carried out to determine the quality rice production potential in response of plant nutrition and weed management.

Material and Methods

The current field experiments were conducted at two consecutive years during Kharif, 2017 and 2018 at Students' Experimental Farm, Department of Agronomy, Sindh Agriculture University, Tandojam, Pakistan. The materials used and methodology adopted during experimentation, has been discussed here briefly. Factor-A: Nutrient levels (F=4) = F_1 = No fertilizer (Control), F_2 = NPK: 160+80+80 kg ha^{-1}, F_3 = NPK + Zn: 160+80+80+6.0 kg ha^{-1}, F_4 = NPK + B: 160+80+80+1.0 kg ha^{-1}. Factor-B: Weed control practices (W=4), W_1 = Weedy check (No weeding), W_2 = Herbicide Machete 60 EC at 2.5 L ha^{-1} (10 DAT), W_3 = sorghum water extract at 25 L ha^{-1} (10 DAT), W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT).

Cultural practices: The rice seed was collected from Nuclear Institute of Agriculture (NIA) Tandojam, and seed rate was applied at 18 kg ha^{-1}. Other cultural practices were adopted as per the standard requirements of the crop.

Data was recorded on the following parameters.

Weed control: Weed control was determined with the help of the following formula:

$$\text{Weed control (\%)} = \frac{\text{Check weed density} - \text{Given treatment weed density}}{\text{Check weed density}} \times 100$$

Panicle length (cm): A total of three fully developed panicles were harvested from the plants. The length of the panicle was determined by measuring its length from base to apex (cm).

Kernel panicle^{-1}: From the plants, we harvested three fully developed panicles. The length of the panicle was determined by counting the number of millimeters from its neck to its tip.

Seed index (1000– kernel weight g): One thousand grains from each plot were collected at random and weighed to record the seed index

Kernel yield (t ha^{-1}): Following threshing, winnowing, and sun drying, the individual rice yield (harvested net plot + sample plants) was recorded in Kg and then converted to tons.

Statistical analysis

The data were statistically analyzed by using Analytical Software Statistix® ver. 8.1 (Hill & Lewicki, 2006). In cases where it was essential, we used the least significant difference (LSD) test to compare the means of the various treatment and their results are interpreted as under:

Results

Weed Control (%): The results for nutrient levels showed significant response to weed control (%) and minimum weed control (38.200 %) at F_4 = NPK + B160 +80+80+1.0 kg ha^{-1}. In case of weed control practices the lowest value (0.00 %) was observed at W_1 = Weedy check (No weeding). The maximum weed control (54.65 %) was recorded at F_1 = No fertilizer (Control). In case of weed control practices the maximum weed control (72.783 %) was recorded at W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT). The results further indicated that the interaction of nutrients levels and weed control practices showed highly significant response for weed control (%). In interaction minimum weed control (0.00 %) was observed with F_1 = No fertilizer (Control) x W_1 = Weedy check (No weeding) and maximum weed control (83.920 %) was recorded with F_1 = No fertilizer (Control) x W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT) respectively (Table 1).

Panicle length (cm): The maximum panicle length (33.34 cm) was recorded at F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1} followed by (31.56 cm) in F_4 = NPK + B 160+80+80+1.0 kg ha^{-1} and the minimum panicle length (25.76 cm) was observed at F_1 = No fertilizer (Control) .In case of weed practices the maximum panicle length (33.11 cm) was recorded at W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT) at .followed by (31.242 cm) was recorded at W_2 = Herbicide Machete 60 EC at 2.5 L ha^{-1} (10 DAT whereas the lowest value panicle length(26.550 cm) was observed at W_1 = Weedy check (No weeding). The results further indicated that the interaction of nutrients levels and weed practices showed highly significant response for panicle length (cm). Maximum panicle length (36.73 cm) was recorded with F_3 = Soil applied NPK + Zn 160+80+80+6.0 kg ha^{-1} x W_4 = Foliar applied Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT) followed by (35.56 cm) at F_4 = NPK + B 160+80+80+1.0 kg ha^{-1} x W_4= Foliar applied W Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT) Whereas, minimum panicle length (23.56 cm) was observed with F_1 = No fertilizer (Control) x W_1 = Weedy check (Noweeding) respectively (Table 2).

Kernel panicle^{-1}: The results for nutrients levels showed significant response to kernel panicle^{-1}. The Maximum kernel (183.67panicle^{-1}) was recorded at F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1} followed by kernel (172.25panicle^{-1}) was observed in F_4 = NPK+ B 160+80+80+1.0 kg ha^{-1} and the minimum kernel (139.42 panicle^{-1}) at F_1 = No fertilizer (Control).In case of weed control practices the maximum kernel (191.50 panicle^{-1}) was recorded at W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT) .followed by (172.33 panicle^{-1}) was recorded at W_2 = Herbicide Machete 60 EC at 2.5 L ha^{-1} (10 DAT) however, the lowest value (143.92 panicle^{-1}) was observed at W_1 = Weedy check (No weeding).The results further indicated that the interaction of nutrients levels and weed control practices showed highly significant response for kernel panicle^{-1}.In interaction maximum kernel (218.67 panicle^{-1}) was recorded with F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1} x W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT) followed by kernel (208.67 panicle^{-1}) at F_4 = NPK+ B 160+80+80+1.0

kg ha^{-1}x W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT) Whereas, minimum kernel was (126.67 panicle^{-1}) observed with F_1 = No fertilizer (Control) x W_1 = Weedy check (No weeding) respectively (Table 3).

Seed Index (1000 kernel wt. g): The results on maximum seed index showed that 22.492 g seed was recorded at F_3= NPK + Zn 160+80+80+6.0 kg ha^{-1} followed by (21.375 g) was observed in F_4 = NPK + B 160+80+80+1.0 kg ha^{-1} and the minimum kernels wt. panicle^{-1} (17.242 g) at F_1 = No fertilizer (Control).In case of weed control practices the maximum seed index (24.225 g) was recorded at W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT) .followed by (23.150 g) was recorded at W_2 = Herbicide Machete 60 EC at 2.5 L ha^{-1} (10 DAT), whereas the lowest value (15.642 g) was observed at W_1 = Weedy check (No weeding) .The interaction of nutrients levels and weed control practices showed highly significant response for seed index (1000 kernel wt. g). Maximum seed index (25.833g) was recorded with F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1} x W_3 = Sorghum water extract at 25 L ha^{-1} (10 DAT), followed by (24.867 g) at F_4 = NPK+ B 160+80+80+1.0 kg ha^{-1} x W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT), Whereas minimum seed index was (13.000 g) observed with F_1 = No fertilizer (Control)x W_1 = Weedy check (No weeding) respectively (Table 4).

Table 1. Weed control (%) of rice under the influence of nutrients levels and weed control practices.

Nutrients levels	Weed control practices				Means
	Weedy check	**Herbicide (2.5 L ha^{-1})**	**SWE (25 L ha^{-1})**	**Herbicide (1.25 L ha^{-1}) + SWE (25 L ha^{-1})**	
F_1 = No fertilizer (Control)	0.00	75.577 ab	59.133 d	83.920 a	54.65 A
F_2 = NPK 160 + 80 + 80 kg ha^{-1}	0.00	61.647 de	45.833 fg	72.050 bc	44.883 B
F_3 = NPK+Zn 160 + 80 + 80 + 6.0 kg ha^{-1}	0.00	62.657 cd	42.283 fg	74.283 ab	44.806 B
F_4 = NPK+B 160 + 80 + 80 + 1.0 kg ha^{-1}	0.00	51.793 ef	40.130 g	60.877 de	38.200 C
Mean	**0.00 D**	**62.918 B**	**46.845 C**	**72.783 A**	-
Variables	**Nutrients levels**		**Weed control practices**		**N × W**
SE	2.5062		2.5062		5.0123
LSD = 0.05	5.1183		5.1183		10.237

Table 2. Panicle length (cm) of rice under the influence of nutrients levels and weed control practices.

Nutrients levels	Weed control practices				Means
	Weedy check	**Herbicide (2.5 L ha^{-1})**	**SWE (25 L ha^{-1})**	**Herbicide (1.25 L ha^{-1}) + SWE (25 L ha^{-1})**	
F_1 = No fertilizer (Control)	23.56 l	26.50 i	24.53 k	28.46 g	25.76 D
F_2 = NPK 160 + 80 + 80 kg ha^{-1}	25.56 j	30.50 e	27.63 h	31.56 d	28.81 C
F_3 = NPK+Zn 160 + 80 + 80 + 6.0 kg ha^{-1}	29.56 f	32.40 c	31.50 d	36.73 a	33.34 A
F_4 = NPK+B 160 + 80 + 80 + 1.0 kg ha^{-1}	27.50 h	35.56 b	29.60 f	35.70 b	31.30 B
Mean	**26.550 D**	**31.242 B**	**28.317 C**	**33.11 A**	-
Variables	**Nutrients levels**		**Weed control practices**		**N × W**
SE	0.0495		0.0495		0.0990
LSD = 0.05	0.1011		1011		0.2022

Table 3. Kernels panicle^{-1} of rice under the influence of nutrients levels and weed control practices.

Nutrients levels	Weed control practices				Means
	Weedy check	**Herbicide (2.5 L ha^{-1})**	**SWE (25 L ha^{-1})**	**Herbicide (1.25 L ha^{-1}) + SWE (25 L ha^{-1})**	
F_1 = No fertilizer (Control)	23.56 l	26.50 i	24.53 k	28.46 g	25.76 D
F_2 = NPK 160 + 80 + 80 kg ha^{-1}	25.56 j	30.50 e	27.63 h	31.56 d	28.81 C
F_3 = NPK+Zn 160 + 80 + 80 + 6.0 kg ha^{-1}	29.56 f	32.40 c	31.50 d	36.73 a	33.34 A
F_4 = NPK+B 160 + 80 + 80 + 1.0 kg ha^{-1}	27.50 h	35.56 b	29.60 f	35.70 b	31.30 B
Mean	**26.550 D**	**31.242 B**	**28.317 C**	**33.11 A**	-
Variables	**Nutrients levels**		**Weed control practices**		**N × W**
SE	0.0495		0.0495		0.0990
LSD = 0.05	0.1011		1011		0.2022

Table 3. Kernels panicle^{-1} of rice under the influence of nutrients levels and weed control practices.

Nutrients levels	Weed control practices				Means
	Weedy check	**Herbicide (2.5 L ha^{-1})**	**SWE (25 L ha^{-1})**	**Herbicide (1.25 L ha^{-1}) + SWE (25 L ha^{-1})**	
F_1 = No fertilizer (Control)	126.67 m	142.33 k	133.67 l	155.00 i	139.42 D
F_2 = NPK 160 + 80 + 80 kg ha^{-1}	142.33 k	168.67 f	141.33 k	183.67 d	159.00 C
F_3 = NPK+Zn 160 + 80 + 80 + 6.0 kg ha^{-1}	158.00 h	196.67 c	161.33 g	218.67 a	183.67 A
F_4 = NPK+B 160 + 80 + 80 + 1.0 kg ha^{-1}	148.67 j	181.67 e	150.00 j	208.67 b	172.25 B
Mean	**143.92 D**	**172.33 B**	**146.58 C**	**191.50 A**	-
Variables	**Nutrients levels**		**Weed control practices**		**N × W**
SE	0.3773		0.3773		0.7546
LSD = 0.05	0.7706		0.7706		1.5411

Table 4. Seed Index (1000 kernel wt. g) of rice under the influence of nutrients levels and weed control practices.

Nutrients levels	Weed control practices				Means
	Weedy check	Herbicide (2.5 L ha^{-1})	SWE (25 L ha^{-1})	Herbicide (1.25 L ha^{-1}) + SWE (25 L ha^{-1})	
F_1 = No fertilizer (Control)	13.000 i	20.367 de	14.000 i	21.600 cd	17.242 D
F_2 = NPK 160 + 80 + 80 kg ha^{-1}	12.933 i	24.133 b	15.380 h	24.600 ab	18.878 C
F_3 = NPK+Zn 160 + 80 + 80 + 6.0 kg ha^{-1}	18.733 fg	22.600 c	19.900 ef	25.833 a	22.492 A
F_4 = NPK+B 160 + 80 + 80 + 1.0 kg ha^{-1}	17.900 g	25.500 a	18.600 fg	24.867 ab	21.375 B
Mean	**15.642 D**	**23.150 B**	**16.970 C**	**24.225 A**	-
Variables	**Nutrients levels**		**Weed control practices**		**N × W**
SE	0.3215		0.3215		0.6430
LSD = 0.05	0.6566		0.6566		1.3133

Table 5. Kernel yield t (ha^{-1}) of rice under the influence of nutrients levels and weed control practices.

Nutrients levels	Weed control practices				Means
	Weedy check	Herbicide (2.5 L ha^{-1})	SWE (25 L ha^{-1})	Herbicide (1.25 L ha^{-1}) + SWE (25 L ha^{-1})	
F_1 = No fertilizer (Control)	4.533 i	6.533 g	5.500 h	7.567 ef	6.0333 D
F_2 = NPK 160 + 80 + 80 kg ha^{-1}	5.467 h	7.667 e	6.600 g	8.633 c	7.0917 C
F_3 = NPK+Zn 160 + 80 + 80 + 6.0 kg ha^{-1}	7.500 f	8.600 cd	8.500 d	11.500 a	9.2583 A
F_4 = NPK+B 160 + 80 + 80 + 1.0 kg ha^{-1}	6.500 g	9.533 b	7.567 ef	9.567 b	8.0583 B
Mean	**6.0000 D**	**8.0833 B**	**7.0417 C**	**9.3167 A**	-
Variables	**Nutrients levels**		**Weed control practices**		**N × W**
SE	0.0322		0.0322		0.0645
LSD = 0.05	0.0658		0.0658		0.1317

Table 6. Protein (%) of rice under the influence of nutrients levels and weed control practices.

Nutrients levels	Weed control practices				Means
	Weedy check	Herbicide (2.5 L ha^{-1})	SWE (25 L ha^{-1})	Herbicide (1.25 L ha^{-1}) + SWE (25 L ha^{-1})	
F_1 = No fertilizer (Control)	7.367 i	8.400 g	7.933 h	9.867 e	**8.392 D**
F_2 = NPK 160 + 80 + 80 kg ha^{-1}	7.533 hi	10.900 d	7.800 h	11.900 c	**9.533 C**
F_3 = NPK+Zn 160 + 80 + 80 + 6.0 kg ha^{-1}	8.500 g	12.567 b	9.400 f	13.000 a	**10.900 A**
F_4 = NPK+B 160 + 80 + 80 + 1.0 kg ha^{-1}	8.400 g	12.700 ab	9.067 f	12.400 b	**10.608 B**
Mean	**7.950 D**	**11.142 B**	**8.550 C**	**11.792 A**	-
Variables	**Nutrients levels**		**Weed control practices**		**N × W**
SE	0.1027		0.1027		0.2054
LSD = 0.05	0.2097		0.2097		0.4195

Kernel yield t ha^{-1}: Results showed that highest kernel yield t (9.2583 ha^{-1}) was obtained at F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1} followed by (8.0583 ha^{-1}) in F_4 = NPK + B 160+80+80+1.0 kg ha^{-1} and the minimum kernel yield t (6.0333 ha^{-1}) was observed at F_1 = No fertilizer (Control). In case of weed control practices the maximum kernel yield t (9.3167 ha^{-1}) was recorded at W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT) followed by 8.0833 was recorded at W_2 = Herbicide Machete 60 EC at 2.5 L ha^{-1} (10 DAT) whereas the lowest value (6.0000 ha^{-1}) was observed at W_1 = Weedy check (No weeding). Interaction of nutrients levels and weed control practices showed highly significant response for kernel yield ha^{-1}. Maximum kernel yield t (11.500 ha^{-1}) was recorded with F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1} x W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT), followed by 9.3167 at F_4 = NPK + B 160+80+80+1.0 kg ha^{-1} x W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT). Whereas, minimum kernel yield t (4.533 ha^{-1}) was observed with F_1 = No fertilizer (Control) x W_1 = Weedy check (No weeding) respectively (Table 5).

Protein content (%): Maximum protein (10.900 %) was recorded at F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1} followed by (10.608 %) in F_4 = NPK+ B 160+80+80+ 1.0 kg ha^{-1} and the minimum protein (8.392 %) at F_1 = No fertilizer (Control) .In case of weed control practices the maximum ash (11.792%) was recorded at W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT) .followed by (11.142 %) was recorded at W_2 = Herbicide Machete 60 EC at 2.5 L ha^{-1} (10 DAT) whereas the lowest value (7.950 %) was observed at W_1 = Weedy check (No weeding) . As per results the interaction of nutrients levels and weed control practices showed highly significant response for protein (%). Maximum protein (13.000 %) was recorded with F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1} x W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT), followed by 12.700 at F_4 = NPK + B 160+80+80+1.0 kg ha^{-1} x W_2 = Herbicide Machete 60 EC at 2.5 L ha^{-1} (10 DAT).Whereas, minimum protein (7.3671 %) was observed with F_1 = No fertilizer (Control) x W_1 = Weedy check (No weeding) respectively (Table 6).

Discussion

In case of weed control practices the minimum values was recorded with W_3 = Sorghum water extract at 25 L ha^{-1}

(10 DAT). However, minimum weed control at F_4 = NPK + B 160+80+ 80+1.0 kg ha^{-1} and lowest value (0.00 %) was observed at W_1 = Weedy check (No weeding). For direct cultivated rice, it is critical to keep field weed free for initial 30 days (Ramana *et al*., 2007). Similar results were also reported by Laxminarayan & Mishra (2001) that weeding and chemical treatments reduced weed population compared to weedy check. Maximum weed density was recorded where no fertilizer was applied. Moreover, maximum weed fresh biomass was recorded in response to the highest dose of fertilizer, i.e. at F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1} while maximum weed dry biomass was recorded at F_4 = NPK + B 160+80+80+1.0 kg ha^{-1}. Furthermore, maximum weed density 90.3 m^{-2} was found at W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + sorghum water extract at 25 L ha^{-1} (10 DAT). The effect of integrated nutrient and weed control practices on rice plant traitsresulted fordifferent nutrient levelsas maximum panicle length cm, kernels $panicle^{-1}$ cm, seed index (1000 kernel wt. g), kernel yield kg (ha^{-1}) and protein (%) was recorded at F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1}. However, maximum crop growth rate (gm^{-2} day^{-1}) recorded at F_4 = NPK + B 160+80+80+1.0 kg ha^{-1}. In terms of integrated nutrient management practices similar findings are reported by Meena *et al*., (2016) and Redovnikovic *et al*., (2017) that a lack of these elements results in stunted root growth, ineffective seed generation, and lower yields. Thus, P and K are essential for nutrient absorption because they stimulate growth.Theweed control practices resulted the maximum panicle length (cm), kernels $panicle^{-1}$, kernels wt. $panicle^{-1}$ (g), seed index (1000 yield wt. g), kernel yield kg (ha^{-1}), and protein (%)was recorded at W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT). However, maximum crop growth rate (gm^{-2} day^{-1}) was recorded at W_3 = Sorghum water extract at 25 L ha^{-1} (10 DAT). The results were in close agreement with Mukherjee & Singh (2005) who indicated that herbicides were viable against weedy species, yet the greater part of them are explicit and are successful against slender scope of weed species. However, interactive effect of integrated nutrient and weed control practices on rice plant traits resulted maximum interactive values for panicle length, kernels $panicle^{-1}$, seed index (1000 kernel wt. g), biological yield (t ha^{-1}), and protein (%) with F_3 = NPK + Zn: 160+80+80+6.0 kg ha^{-1} x W_4 = Herbicide Machete 60 EC at 1.25 L ha^{-1} + Sorghum water extract at 25 L ha^{-1} (10 DAT).The maximum kernels wt. $panicle^{-1}$ (g) was recorded with F_3 = NPK + Zn 160+80+80+6.0 kg ha^{-1} x W_3 = Sorghum water extract at 25 L ha^{-1} (10 DAT). Laxminarayan & Mishra (2015) further depicted that there is need to explore the efficacy of the method of controlling weeds with the application of fertilizers for augmenting the crop yield. Consequently, Plett *et al*., (2020) also advocated for incorporation of new phenotypic technologies, breeding strategies, and agronomic practices to improve crop yield production systems. It is concluded that rice as major nutritional crop of world, people need well sensitization about adequate management of plant nutrients and weeds control (Plett *et al*., 2020). Consequently, nutrient management is critical in rice cultivation to achieve a stable grain yield and a good economic return while improving product quality (Paul *et al*., 2021). A well understanding in terms of NPK levels, zinc, boron and weed management as well as suitable integration to support maximization of quality rice production is prerequisite. Therefore, adequate management of plant nutrients and weeds is crucial for the enhanced yield and quality of rice.

Conclusion

The study confirms to establish adequate management practices through different levels of nutrients and weed control for the enhancement of quality Paddy (rice) production. The integrated application of plant nutrients and weed control practices should be applied from sowing to harvesting for achieving higher yield of rice crop. The extended study of field and laboratory experiments should be conducted to determine efficacy of different NPK nutrient levels in terms of rice crop. Rice growers' capacity should be raised while dealing with the rice plant nutrition to get higher yield by applying integrated approach with efficient weed control measures.

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