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Influence of fertilizer levels and weed management practices on growth and yield of hybrid rice

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Abstract
A field experiment entitled "Influence of fertilizer levels and weed management practices on growth and yield of hybrid rice" was conducted during the *kharif* season of 2017 at the Research Farm, TCA, Dholi, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur (BIHAR). The experiment was laid out in split-plot design with twelve treatments. The results revealed that there was a significant difference in various plant growth parameters at harvest like plant height (112.78 cm), number of tillers/m^2 (317.22), plant dry matter (1291.80 g/m^2), crop growth rate (6.27 g/m^2/day 90 DAT-at harvest) and yield parameters i.e. the number of panicles (213.05/m^2), length of panicle (29.30 cm), number of spikelets/panicle (224.16) and test weight (22.82 g), grain yield (62.35 q/ha) and straw yield (88.00 q/ha) recorded highest with hand weeding twice (20 and 40 DAT) which was found statistically at par with Bispyriback sodium @ 25 g /ha + Pyrazosulfuron @25 g/ha at 20 DAT and significantly superior over rest of the treatments. Among fertilizer levels, growth parameters at harvest i.e. plant height (112.67 cm), number of tillers/m^2 (315.83), plant dry matter (1180.49 g/m^2) and yield parameters i.e. the number of panicles (208.33/m^2), length of panicle (28.91 cm), number of spikelets/panicle (229.52) and test weight (22.77 g), grain yield (55.73 q/ha) and straw yield (78.36 q/ha) were recorded highest with the application of 150% RDF, which was found statistically at par with 125% RDF and significantly superior over 100% RDF.

Keywords: Influence, fertilizer, management practices, hybrid, *Oryza sativa* L.

Introduction
Rice (*Oryza sativa* L.) is the most important staple food crop of India and more than half of the world's population depends on it for food, calories and protein. The world's total area under rice cultivation is 161.1 m. ha and production were about 480.3 MT along with the productivity of 2.98 t/ha (STATISTA-The statistics portal, 2016-17). In India, rice is cultivated in 44.1 M ha area with an annual production of 106.7 MT and average productivity is 2.4 t/ha. Since the yield of high yielding varieties (HYVs) of rice is plateauing, it is rather difficult to achieve this target with the present inbred varieties. Therefore, to sustain the self-sufficiency in rice an additional production of 1.5 MT is needed every year. Among the limited options, hybrid technology is the most proven technology currently available for stepping up rice production significantly. The rice hybrids, recently introduced in cultivation, on an average, give 10 to 15 q/ha additional yield over the conventional varieties (about 20% increase). Therefore, the introduction of hybrids and popularization of their production techniques are feasible and readily adaptable to achieve targeted production

Weeds are widely regarded as pests of great agricultural menace as they pose serious problems by causing severe competition with crop plants for nutrients, moisture, solar energy and space. So, weeds bring heavy reductions in growth and yield of a crop. Yield reduction in transplanted rice has been reported to be 28-45% due to uncontrolled weeds (Singh *et al.* 2003) [8]. Besides yield reduction, weed depletes nutrients from soil to an extent of 42.07 kg nitrogen, 10 kg phosphorous and 21.08 kg potassium per hectare respectively (Puniya *et al.* 2007) [8]. Weed management is an important component of plant protection, that can be accomplished by cultural, mechanical and chemical methods. Out of three, the chemical method is more efficient in time and quickly controlling of weeds. The chemical method is vital for effective and efficient control of weeds. Despite the usage of several herbicidal combinations, a lot of escapes or regeneration has been noticed. Therefore, considering the long window of the emergence of diverse types of weeds it can't be solved by a one-time application of herbicides alone.

Considering these problems, the application of several herbicides in combination or sequence can be utilized in controlling complex and diverse weed flora. Many rice varieties particularly hybrid ones respond markedly to fertilization. Nutrient management must be sound for sustainably achieving the production target. The use of chemical fertilizer is the fastest way of counteracting the pace of nutrient mining. It promotes the growth and development of rice crop and responsible for over 50 percent of the crop yield increment. Nitrogen, phosphorous and potassium are the most critical essential elements influencing plant growth and production of the crop throughout the world. Nitrogen is known as the key nutrient of rice production. It is one of the most important and essential nutrient which directly influences the growth, development, yield and quality of rice. The next limiting nutrient which reduces the productivity of rice is phosphorous as it is required for cell division, seed formation, crop maturation, root growth and development. The phenomenon of grain filling and crop lodging is influenced by potassium fertilization. Keeping the above facts in view the present investigation was carried out to study the effect of fertilizer levels and weed management practices on the growth and yield of hybrid rice.

Materials and Methods

A field experiment was conducted during the kharif season of 2017 at the Research Farm, TCA, Dholi, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur (BIHAR). The experiment was laid out in split-plot design with twelve treatments. The main plot comprised four different weed management practices i.e. W1 (Bispyribac-sodium @ 25 g/ha at 20 DAT), W2 (Bispyribac-sodium @ 25 g/ha + Pyrazosulfuron @ 25 g/ha at 20 DAT), W3 (Hand weeding twice at 20 and 40 DAT) and W4 (Weedy check), and under the sub-plot there were three fertilizer levels i.e. F1 (100% RDF), F2 (125% RDF) and F3 (150% RDF), which were replicated thrice. Rice hybrid "ARIZE-6444" was taken as the test variety. The soil of the experimental field was sandy loam in texture with moderately alkaline in reaction (pH 8.2), low in organic carbon (0.39%), available N (207.30 kg/ha), P2O5 (16.55 kg/ha). and K2O (132.80 kg/ha). The experiment was laid out in split-plot design with weed management in main-plot and fertilizer levels in sub-plot with three replications. The treatments were randomized as per the procedure given by Cochran and Cox (1952) [1].

For a nursery, an area of 100 m2 was selected ploughed and brought into ideal condition. The nursery area was fertilized with a basal dose of 1 kg urea and 1 kg DAP. Weeding and plant protection measures were taken up as and when it felt necessary. Good quality of seeds of cultivar, ARIZE-6444 @ 13 kg/ha was sown on well prepared nursery bed for transplanting method of establishment. Then the main field was divided into subplots as per the layout plan. Two seedlings per hill of 21 days old seedlings were transplanted at a spacing of 20 cm X 20 cm in the field. The crop was fertilized with 100 kg N/ha, 60 kg P2O5/ha, 50 kg K2O/ha and 25 kg ZnSO4/ha based on RDF in different treatment plots. Nitrogen was applied in the form of diammonium phosphate and urea (46%N), whereas, Phosphate, Potassium and Zinc were applied in the form of DAP (46% P2O5), Murate of Potash (60%K2O) and Zinc Sulphate (25% Zn), respectively. Nitrogen was applied in three splits i.e. 25 per cent at the time of sowing, 50 per cent at active tillering stage and 25 per cent at the panicle initiation stage. The entire quantity of phosphorus and potassium was applied as basal. Zinc sulphate was applied @ 25 kg/ha at last puddling operation. As per the treatments, herbicide Bispyribac-sodium @ 25 g/ha was applied at 20 days after transplanting in W1. A combination of Bispyribac-sodium @ 25 g/ha and Pyrazosulfuron@ 25 g/ha was applied at 20 days after transplanting in W2. Two hand weedings were done at 20 and 40 days after transplanting manually (using khurpi) in W3. W4 was kept as a weedy check. Recommended package and practice for disease and insect management in the region for rice crop was followed. The crop was harvested when leaves turned brown and ear head gave a metallic sound when the wind blows. Observations on various growth and yield attributing characters were recorded by randomly selecting five competitive plants of each treatment in a replication, which were tagged properly. The growth and yield parameters of the crop during the experimental duration were recorded at regular intervals, to assess the probable relationship between growth attributes and the final yield. The significance of the treatment impact was examined by the F test. Standard errors of variances were calculated and recorded simultaneously with the summary results. Critical differences for various groups of treatments at a 5% level of significance were computed.

Results and Discussion

Crop growth parameters

Plant growth parameters *viz*. plant height (cm), number of tillers/m2, plant dry matter (g/m2) and crop growth rate (g/m2/day) were studied during the investigation (Table.1). All these characters were significantly influenced by both weed management practices and fertilizer levels.

Hand weeding twice (20 and 40 DAT) recorded significantly higher values of plant growth parameters, which was found statistically at par with Bispyribac-sodium @ 25 g/ha + Pyrazosulfuron @ 25 g/ha at 20 DAT and significantly superior over Bispyribac-sodium @ 25 g/ha at 20 DAT and weedy check. This might be due to effective control against narrow, broad leaved weeds grasses and sedges which provided less crop-weed competition and favorable environment for nutrients, light, moisture, space and other favorable conditions for crop growth that resulted in more accumulation of photosynthates and an increased the plant height, number of tillers, and other growth parameters enabled to accumulate the maximum amount of dry matter. Lower values were recorded in the weedy check at all growth stages. Due to the presence of a greater number of weeds where crop failed to compete with the weeds for nutrients, water, light and space and exerted a high degree of competition with the crop. Similar findings were reported by Moorthy (2002) [5], Payman and Singh (2008) [7]. Among fertilizer levels, the maximum plant height, number of tillers dry matter accumulation and crop growth rate at different crop growth stages were recorded with the application of 150% RDF which was found statistically at par with 125% RDF and significantly surpassed over 100% RDF. An increase in crop growth and dry matter accumulation was observed with increasing levels of fertilizer at all stages of growth. The application of higher nutrients provides an adequate amount of nutrients in a balanced proportion to the crop plant resulted in the good establishment of roots and various metabolic processes. A larger concentration of nutrients in the cell-sap promotes rapid cell division, a differentiation that performed better nutrient mobilization which resulted in maximum stem elongation, faster growth and the cumulative effect of photosynthesis due to increased availability of nutrients that

led to increased plant height, number of tillers/m2 and dry matter production. Similar observations were reported by Nagappa *et al*. (2002) [6], Maiti *et al*. (2006) [4], Singh *et al*. (2009) [14] Yield attributing characters are mainly dependent on the foundation laid down by different growth characters. Yield attributing characters *viz*.- number of panicles/m2 at harvest, length of panicle (cm), number of spikelets/panicle, number of filled spikelets/panicle, number of unfilled spikelets/panicle and 1000-grain weight (g) were significantly influenced by different weed management practices and fertilizer levels.

Among different weed management practices, yield attributing parameters at harvest were observed significantly higher in hand weeding twice treatment which was found statistically at par with Bispyribac-sodium @ 25 g/ha + Pyrazosulfuron @ 25 g/ha at 20 DAT and significantly superior over Bispyribac-sodium @ 25 g/ha at 20 DAT and weedy check. This might be due to the minimum weed population and biomass at different growth stages resulting in the availability of a more congenial environment for plant growth and development. Lower values were recorded under the weedy check plot might be due to multiple weed problems. The number of unfilled spikelets/panicle showed no significant difference among weed control measures but was significantly higher under the weedy check. This may be due to less crop weed competition for different growth factors among different weed management practices and the highest competition in weedy check. This finding was corroborated by Shekhar *et al*. (2004) [12].

Similarly, in the fertilizer level significantly higher value of yield attributing parameters were recorded under 150% RDF but it was found at par with 125% RDF and significantly superior over 100% RDF. However, the number of unfilled spikelets/panicle recorded no significant difference among the fertilizer levels. This finding was corroborated by Increasing the fertilizer dosage helps in better nourishment of plants due to the uptake of more nutrients from the soil which enhances the photosynthetic rate, accumulation of photosynthates and translocation of photosynthates to sink effectively triggers the physiological activities and improve the growth and development of the plant. Similar findings were reported by Thomas *et al*. (2003) [16] Ramachandrian and Balasubramanian (2012) [10], Rishi raj *et al*. (2016) [9]

A perusal of the mean data presented in Table 4 revealed that among different weed management practices in rice crop the higher grain yield (62.35 q/ha), straw yield (88.00q/ha) and harvest index (41.46%) was recorded in hand weeding twice and found statistically at par with Bispyribac-sodium @ 25 g/ha + Pyrazosulfuron @ 25 g/ha at 20 DAT and was significantly superior over Bispyribac-sodium @ 25 g/ha at 20 DAT and weedy check. This might be due to lesser crop-weed competition which led to higher growth, better yield characters, lesser weed density and dry weight and thus more economic yield as compared to other treatments. The minimum grain yield was recorded in weedy check might be due to severe weed infestation in the crop field. The weeds growing in weedy check attained higher vigor to compete with the crop plants for growth factors throughout the growing season and thus suppressed the crop plant which could not express the fullest yield potential as was also corroborated by Rao *et al*. (2008) [11], Yadav *et al*. (2009) [17], Kachroo and Bazaya (2011) [2]. Similarly, among fertilizer levels, maximum grain yield (55.73 q/ha), straw yield (78.36 q/ha) and harvest index (41.46) were observed in 150% RDF which was found statistically at par with 125% RDF and significantly superior over 100% RDF. Higher grain yield with a higher level of fertilizer might be due to better availability and uptake of nutrients and photosynthetic efficiency leading to higher plant dry matter production and ultimately increasing grain yield. Plant under 150% RDF might not have realized nutrient deficits caused by weed infestation during peak vegetative and developmental phases and had favorable soil moisture conditions for optimum physiological functions. They grew freely to receive enough sunshine for carbohydrates synthesis resulting in better growth of the plant, longer panicle, a greater number of effective tillers, a greater number of grains per panicle and higher test weight these ultimately resulted in increased grain yield. Similar results were obtained by Kumar, K. *et al*. (2005) [9].

Keeping in view the present experiment that it was conducted at a single location for only one season, the following broad conclusions can be drawn concerning growth parameters, yield attributes and yield, hand weeding twice at (20 and 40 DAT) recorded higher yield was found statistically at par with the application of Bispyribac-sodium @ 25 g/ha + Pyrazosulfuron @ 25 g/ha at 20 DAT and significantly superior over rest of the treatments. Significantly lowest value of growth parameters, yield attributes and yield were recorded under weedy check. Among fertilizer levels, the highest growth, yield attributes and yield were recorded by 150% RDF which was statistically at par with 125% RDF and significantly superior to 100% RDF.

Table 1: Growth attributing characters of rice as affected by fertilizer levels and weed management practices

	Plant height (cm)			**Number of tillers/m^2**			**Plant dry matter/m^2**			**Crop growth rate (g/m^2/day)**		
Weed Management practices	**60**	**90**	**At harvest**	**60**	**90**	**At harvest**	**60**	**90**	**At harvest**	**30-60**	**60-90**	**90-At harvest**
Bispyriback sodium @ 25 g /ha at 20 DAT	87.64	103.11	107.78	309.44	288.06	276.95	516.83	1000.02	1163.53	14.01	16.11	5.45
Bispyriback sodium @ 25 g /ha + Pyrazosulfuron @25 g/ha at 20 DAT	89.15	105.56	110.78	345.28	313.61	291.39	550.28	1075.58	1251.80	14.95	17.51	5.87
Hand weeding twice (20 and 40 DAT)	90.43	107.44	112.78	361.67	340.00	317.22	558.00	1103.64	1291.80	15.15	18.19	6.27
Weedy check	85.50	99.89	104.00	272.50	254.45	216.67	399.52	786.94	844.84	11.37	12.95	1.93
S. Em.±	0.51	1.18	0.69	5.07	13.37	11.21	9.73	11.38	13.65	0.28	0.46	0.40
CD (P=0.05)	1.81	4.16	2.44	17.90	47.15	39.56	34.31	40.15	48.16	0.98	1.61	1.42
Fertilizer levels												
100% RDF.	86.31	98.75	103.75	275.62	253.54	230.42	463.02	941.97	1077.08	12.73	15.97	4.50
125% RDF.	88.77	105.25	110.08	331.46	307.92	280.42	517.68	997.97	1156.40	14.25	16.01	5.28
150% RDF	89.48	108.00	112.67	359.83	332.62	315.83	537.02	1034.68	1180.49	14.80	16.59	4.86
S. Em.±	0.75	1.19	1.07	15.87	14.93	14.82	15.237	21.31	17.88	0.44	0.46	0.60
CD (P=0.05)	2.27	3.61	3.23	48.00	45.14	44.80	46.07	64.45	54.06	1.31	NS	NS

Table 2: Yield and yield attributing characters of rice as affected by fertilizer levels and weed management practices

Weed Management practices	Number of Panicles /m²	Length of panicle	spikelets /panicle			1000 seed Weight (gm)	Grain yield (q/ha)	Straw yield (q/ha)	Harvest Index (%)
			Total spikelets	Filled spikelets	Unfilled spikelets				
Bispyriback sodium @ 25 g /ha at 20 DAT	177.72	27.56	214.18	182.16	32.01	21.93	50.43	71.44	41.28
Bispyriback sodium @ 25 g /ha + Pyrazosulfuron @25 g/ha at 20 DAT	199.97	28.74	223.42	191.74	31.68	22.41	60.23	85.03	41.45
Hand weeding twice (20 and 40 DAT)	213.05	29.30	224.16	193.53	30.61	22.82	62.35	88.00	41.46
Weedy check	126.75	25.47	203.97	160.65	43.32	21.10	33.75	47.94	41.00
S. Em.±	8.60	0.26	2.81	1.05	2.32	0.19	0.87	1.24	0.05
CD (P=0.05)	30.36	0.91	9.92	3.72	8.21	0.66	3.09	4.38	0.18
Fertilizer levels									
100% RDF.	147.77	26.26	197.46	160.35	37.10	21.47	46.14	65.76	41.05
125% RDF.	182.02	28.13	222.31	189.14	33.17	21.96	53.21	75.19	41.38
150% RDF	208.33	28.91	229.52	196.57	32.94	22.77	55.73	78.36	41.46
S. Em.±	9.59	0.50	3.45	2.84	1.59	0.23	1.64	2.29	0.05
CD (P=0.05)	29.02	1.53	10.43	8.60	NS	0.71	4.95	6.94	0.16

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