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Graded Levels of Major Nutrients and different Organic Manures on Growth and Yield of Hybrid Rice (KRH-4)

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ABSTRACT

The present investigation was conducted to study the effect of graded levels of nutrients and different organic manures on growth and yield of hybrid rice (KRH-4). The results indicated that growth parameters like plant height, number of bra per plant, total dry matter production and yield parameters like number of productive tillers hill^{-1}, panicle length (cm), total number of grains panicle^{-1} and thousand grain weight (g) increased from 75 to 125 per cent of NPK applied through RDF treatments. Grain yield (7785.9 kg ha^{-1}), straw yield (8616.8 kg ha^{-1}) and harvest index was observed highest in both inorganic and organic applied treatment *i.e.,* 125 per cent NPK through RDF with pongamia.

Keywords : Graded levels of nutrients, organic manure, FYM, green manure, KRH-4

RICE (*Oryza sativa* L.) is one of the most important cereal crop grown extensively in India during *kharif* season. It is the staple food for more than 40 per cent of the world's population. The dawn of 21st century poses very tough challenges to agriculture with a slogan to produce more food to nourish the increasing human population from shrinking land which needs sustainable agriculture. It will be challenging task for agricultural scientists with shrinking arable land and only alternative is vertical growth in agriculture production through increased production per unit area per unit time (Bedi, 2009). Furthermore, increasing the production, quality and productivity on sustainable basis is yet another challenge to agricultural scientists and policy makers.

Fertilizers are essential among different factors contributing towards agricultural production. The benefits of increased use of fertilizers in achieving targets of food grain production are well established. However, practice of farming with high yielding crop varieties under present constraints is different due to the ever increasing fertilizer prices. A viable proposition would be the adoption of economic and judicious use of fertilizers and management practices so that the higher investment on fertilizers is reaped adequately. Further, chemical fertilizers alone are unable to maintain long-term soil health and sustain crop productivity as they are unable to supply all the essential nutrients. Unless the system is provided with adequate and balanced nutrition, there will be continuous mining of nutrients causing yield decline. Balanced and integrated nutrient use *i.e.*. the application of organics and chemical fertilizers not only sustains higher crop yields but also maintains soil health.

Increasing the production and productivity in rice through research is of great value in the service of mankind and the nation. Judicious application of chemical fertilizers based on soil test combined with organic manures can help to meet the challenges of twenty first century in agricultural production. Hence an effort was made to study the influence of graded levels of nutrients and different organic manures on growth and yield of hybrid rice (KRH-4).

MATERIAL AND METHODS

Studies on the graded levels of nutrients and different organic manures on yield and uptake of hybrid rice (KRH-4)were conducted at ZARS, Mandya during *kharif* 2015. The experimental site is situated at 12^0 36^1 North latitude and 77^0 4^1 East longitude and at an altitude of 662 meters above mean sea level. It is included in Southern dry zone, (Agro-climatic zone VI) of Karnataka. Prior to laying out the experiment, composite soil samples were drawn from a depth of 0-15 cm depth and analysed for physical and chemical characteristics. The soil was sandy loam with pH of 7.58, EC of 0.53 dSm^{-1}, organic carbon 0.38 per cent

and available nutrients like nitrogen, phosphorus and potassium were 187.80, 24.12 and 430.80 kg ha^{-1}, respectively.

Treatment details

The experiment was laid out in Randomized Complete Block Design (RCBD). The experiment comprised of 17 treatments: T_1 (Absolute control), T_2 (75% NPK through RDF + FYM), T_3 (75% NPK through RDF + Pongamia), T_4 (75% NPK through RDF + Glyricidia), T_5 (75% NPK through RDF + Sunhemp), T_6 (100% NPK through RDF + FYM), T_7 (100% NPK through RDF + Pongamia), T_8 (100% NPK through RDF + Glyricidia), T_9 (100% NPK through RDF + Sunhemp), T_{10} (125% NPK through RDF + FYM), T_{11} (125% NPK through RDF + Pongamia), T_{12} (125% NPK through RDF + Glyricidia), T_{13} (125% NPK through RDF + Sunhemp), T_{14} (100% NPK through STCR + FYM), T_{15} (100% NPK through STCR + Pongamia), T_{16} (100% NPK through STCR + Glyricidia), T_{17} (100% NPK through STCR + Sunhemp). As per the treatments N, P and K nutrients were applied through urea, SSP and MOP fertilizers, respectively. Organic manures like FYM and green manures like pongamia, glyricidia and sunhemp were also analysed and given in the Table I. Hybrid rice (KRH-4) cultivated as a test crop as per the recommended cultural practices. The seedlings of 25 day old were transplanted at a time in all the experimental plots maintaining a spacing of 20 cm x 10 cm although the green manure @ 5t / ha on dry weight basis was incorporated into the soil 15 days before transplanting and $ZnSO_4$ @ 25 kg / ha were applied to all the treatments. Intercultural operations such as irrigation and weeding were done as and when necessary.

The crop was harvested at full maturity. Five hills were randomly selected from each plot to record the yield contributing characters. Grain and straw yields were recorded plot wise and converted to kg ha^{-1}. Harvest index (HI) was computed as:

$$HI = \frac{\text{Grain yield (Kg ha}^{-1})}{\text{Biological yield (Kg ha}^{-1})}$$

The observations recorded during the course of investigation were tabulated and analyzed statistically to draw a valid conclusion. The data were analyzed

TABLE I

Nutrient content in different organic manure

Particulars	FYM	Pongamia	Glyricidia	Sunhemp
Major nutrients				
Nitrogen (%)	0.67	3.05	2.33	2.11
Phosphorus (%)	0.22	0.50	0.32	0.43
Potassium (%)	0.44	3.55	3.05	1.53
Secondary nutrients				
Calcium (%)	0.88	1.22	1.08	0.56
Magnesium (%)	0.39	0.33	0.36	0.14
Sulphur (%)	0.34	0.45	0.34	0.24
Micro nutrients				
Boron (mg kg^{-1})	12.00	22.23	9.75	17.50
Iron (mg kg^{-1})	630.87	439.87	224.09	468.78
Zinc (mg kg^{-1})	76.45	72.78	55.89	41.87
Copper (mg kg^{-1})	12.76	3.78	1.56	1.50
Manganese (mg kg^{-1})	444.7	102.78	54.87	28.78

as per the standard procedure for "Analysis of Variance" (ANOVA) as described by Gomez and Gomez (1984). The significance of treatments was tested by RCBD design. Standard error of mean (SEm±) was computed in all cases. The difference in the treatment mean were tested by using critical difference (CD) or least significant difference (LSD) at 5% level of probability. Regression analysis was also performed.

Results and Discussion

The growth parameters of hybrid rice like plant height, Number of tillers per hill and Total dry matter production (g hill^{-1}) as affected by different treatments, recorded at 30, 60, 90 days after transplanting (DAT) and at harvest are presented in Table II.

The growth attributes were increased with increasing levels of NPK along with organics especially in green manures at 30DAT, 60DAT, 90DAT and at harvest. The higher growth attribute were recorded in the treatment coupled with both organics and inorganics *i.e.,* 125 % NPK through RDF with pongamia and this was superior over all the treatments. The treatment 100% NPK through STCR along with organics (T_{14} to T_{15}) was superior over the 75 and 100 % NPK through RDF with organics (T_2 to T_9). The lower growth was observed in treatment with no organics and inorganics (T_1: absolute treatment).

Further, it is evident from the data that among organics, the maximum plant height was observed with pongamia which was significantly higher than other organics like glyricidia, sunhemp and farm yard manure at all stages of crop growth. Increased availability of nutrients in the soil through mineralization of pongamia green leaf manure could have triggered cell elongation and multiplication resulting in high growth rate of shoot in turn plant height of hybrid rice over control. Similar results were obtained by Guggari and Kalaghatagi (2001). The improvement in plant height in response to organic manures over control might be due to enhanced availability of both macro and micro nutrients; in particular nitrogen, besides improvement in soil microbial activity. These results are supported by the findings of Pramanik*et al*., (2004) who reported enhanced plant height with the incorporation of green manures.

The yield attributes were increased with increasing level of RDF along with organics (FYM and green manures like pongamia, glyricidiasunhemp). The yield attributes like number of productive tillers hill^{-1} number of grains panicle^{-1}and 1000 grain weight (g) were significant among the treatment. Highest was recorded in the treatment which receives high dose of NPK fertilizers along with green manures i.e., 125 % NPK through RDF + pongamia (Number of productive tillers hill^{-1} of 27.27; Number of grains panicle^{-1}of 282.83; 1000 grain weight of 23.87 g) and lower yield attributes were recorded in absolute control (Number of productive tillers hill^{-1} of 13.67; Number of grains panicle^{-1}of 210.00; 1000 grain weight of 18.50 g). panicle length did not showed significant difference among treatments (Table III).

The higher yield attributes might be due to higher levels of inorganic fertilizers which increased the activity of photosynthesis and enzymes responsible for transformation of energy, carbohydrates, fat metabolism and respiration of plant. Organic manures acting as slow release source of N are expected to more closely match with N and supply of other nutrients which demanded for rice crop and this could reduce the N losses and also improved the nutrient use efficiency particularly of nitrogen (Arunkumar*et al*., 2014; Srivastava *et al*., 2016). Therefore, inorganic fertilizers in combination with organic manures caused the greater translocation of photosynthates from source to sink site resulted inhigher yield contributing characters of rice (Barik *et al*., 2008).

Significantly higher grain yield (7785.9 kg ha^{-1}) and straw yield (8616.8 kg ha^{-1}) were recorded under 125% NPK through RDF + pongamia than other treatments. Minimum yield of grain, straw and protein content was observed in treatment without organics and inorganics.

The higher yield associated with higher level of inorganic fertilizers in combination with organic manures may be due to its greater availability and uptake of macro and micro-nutrients and active participation in carbon assimilation, photosynthesis, starch formation, translocation of protein and sugar, entry of water into plant roots and development etc. It also enhances the process of tissue differentiation

TABLE II

Growth parameters of hybrid rice (KRH-4) at different stages as influenced by graded levels of major nutrients and different sources of organic manures

Treatments	Plant height (cm)				Number of tillers per hill				Total dry matter production (g hill^{-1})			
	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest
T_1	41.01	59.98	85.01	94.12	8.33	17.81	20.63	18.50	17.84	39.48	68.45	84.34
T_2	44.33	65.39	87.33	107.29	12.02	21.21	26.85	23.40	18.32	42.65	72.67	92.65
T_3	44.96	66.15	93.45	109.41	13.20	26.62	30.83	28.98	19.20	46.89	74.75	95.87
T_4	44.49	65.62	93.35	108.55	10.52	25.82	29.05	21.54	18.50	43.70	73.34	94.53
T_5	44.51	64.43	90.69	107.64	12.12	22.83	28.41	26.50	18.82	43.12	73.10	93.80
T_6	45.35	67.10	90.06	109.84	13.48	25.40	33.23	31.10	19.30	47.25	75.37	94.65
T_7	46.60	70.61	95.72	113.68	15.88	29.41	35.24	30.12	21.43	48.54	78.56	99.45
T_8	45.58	68.19	93.53	112.47	13.98	28.40	33.42	29.50	19.40	47.95	76.76	95.40
T_9	45.34	67.68	92.03	110.56	12.43	25.60	31.41	27.40	19.32	46.42	75.99	94.90
T_{10}	50.51	70.34	101.42	119.92	16.02	34.60	39.33	35.44	23.30	50.99	83.65	105.97
T_{11}	52.27	76.11	102.01	125.31	19.20	37.40	43.23	37.93	26.81	54.56	86.65	109.29
T_{12}	51.22	74.62	101.92	119.98	18.13	35.42	41.95	36.80	24.10	52.50	84.78	108.00
T_{13}	51.27	72.68	99.95	119.63	16.18	33.00	40.28	33.52	22.97	50.45	83.10	106.47
T_{14}	47.35	68.95	96.30	116.70	13.68	29.54	36.41	31.47	20.45	48.78	79.45	99.95
T_{15}	50.29	72.05	97.39	117.40	12.73	32.62	37.07	31.53	22.40	50.93	81.56	103.40
T_{16}	47.57	69.68	94.91	120.08	15.42	32.27	35.41	32.93	20.57	49.98	79.27	101.90
T_{17}	47.76	70.97	95.57	118.94	15.90	31.83	32.20	31.92	20.44	49.37	79.32	100.40
S.Em±	3.43	2.74	2.75	5.13	1.38	2.83	2.07	2.45	2.26	2.56	3.22	5.13
C.D.(p=0.05)	NS	7.90	7.92	14.79	3.96	8.14	5.95	7.07	6.51	7.37	9.27	14.78

TABLE III

Yield parameters of hybrid rice (KRH-4) at different stages as influenced by graded levels of major nutrients and different sources of organic manures.

Treatments	No. of productive tillers hill $^{-1}$	Panicle length (cm)	No. of grains panicle $^{-1}$	1000 grain weight (g)	Grain yield (kg ha $^{-1}$)	Straw yield (kg ha $^{-1}$)	Harvest index
T_1	13.67	21.61	210.00	18.50	6217.8	7229.7	0.46
T_2	15.67	22.49	227.33	18.87	6563.4	7580.6	0.46
T_3	18.33	23.33	235.83	20.13	6843.6	7701.2	0.47
T_4	17.60	22.86	231.50	18.77	6717.0	7633.0	0.47
T_5	16.87	22.60	229.00	18.70	6634.4	7565.5	0.47
T_6	17.80	22.80	236.83	19.33	6668.3	7688.9	0.46
T_7	21.80	23.75	248.17	20.23	6881.6	8050.9	0.46
T_8	19.67	23.12	234.83	20.03	6751.6	7901.2	0.46
T_9	18.73	23.04	235.83	19.90	6781.9	7837.6	0.46
T_{10}	24.07	24.09	263.33	21.77	7427.7	8228.1	0.47
T_{11}	27.27	25.05	282.83	23.87	7785.9	8616.8	0.47
T_{12}	25.00	24.48	275.67	22.13	7513.4	8412.6	0.47
T_{13}	23.67	23.80	261.50	21.40	7332.3	8242.9	0.47
T_{14}	21.80	23.16	247.78	19.87	7092.9	7928.8	0.47
T_{15}	23.27	24.11	257.39	20.87	7307.8	8137.4	0.47
T_{16}	22.20	23.42	247.78	20.60	7218.2	7846.5	0.48
T_{17}	21.87	23.00	241.50	20.47	7223.0	7993.4	0.47
S.Em±	1.80	1.40	9.34	0.78	242.5	226.2	0.01
C.D.(p=0.05)	5.19	NS	26.92	2.25	698.6	651.6	NS

i.e., from somatic to reproductive phase leading to higher grain and straw yield. This was also may be due to the higher yield attributes under this treatment. Rice yield was significantly improved by incorporating green manure and nitrogen application as compared to control (Mohanty*et al.,* 2013). (Arunkumar*et al*., 2014). The results are also in conformity with findings of Kumar and Singh (2006); Hossaen*et al*. (2011).

Perusal of data indicated that harvest index of hybrid rice was not significantly influenced by graded levels of nutrients and organics like FYM and green manures (Pongamia, glyricidia and sunhemp). There was a proportionate increase in both grain and straw yields with increased level of nutrients, thus resulting in non-significant harvest index. Similar results were obtained by Patil and Shete (2008).

Relationship between grain yield and yield attributes of hybrid rice

Yield attributes like number of productive tillers per hill, panicle length, number of grains per panicle and 1000 grain weight showed significant positive linear association with grain yield (Fig. 1) and was described by the equation 1 to 4.

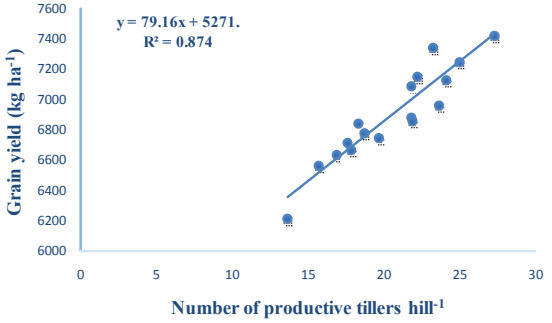

Fig. 1 : Relationship between grain yield and number of productive tillers hill^{-1}

Number of productive tillers explained 87.41 per cent variability of the grain yield. Hence, increasing the number of productive tillers can increase the grain yield of hybrid rice and it has positive relation on grain yield. Panicle length had a significant linear association with grain yield (Fig. 2) and the equations 2 expressed the quadratic models of the relationship. Panicle length described the variability of grain yield by 85.96 per cent.

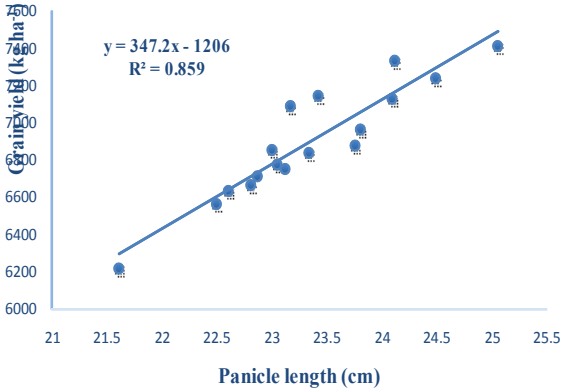

Fig. 2 : Relationship between grain yield and panicle length

A positive quadratic association between number of grains per panicle and grain yield of hybrid rice was observed (Fig. 3). The fitted regression model could be described by the equation no. 3. Number of grains per panicle accounted for 91.51 per cent of the variability of hybrid rice grain yield.

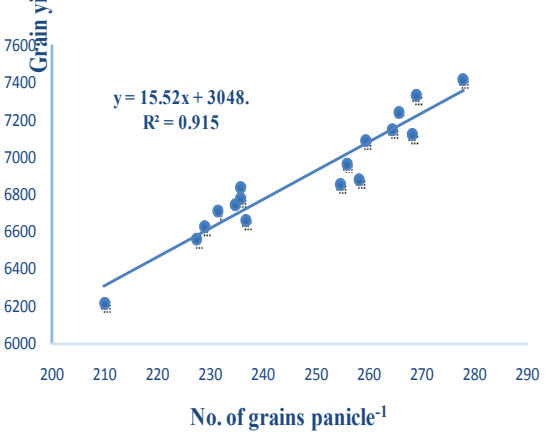

Fig. 3 : Relationship between grain yield and No. of grains panicle^{-1}

Grain yield of hybrid rice increased linearly with the increase in test weight (Fig. 4). The fitted regression model was described by the equation 4. 1000 grain weight accounted for 76.49 per cent of the variability of grain yield of hybrid rice

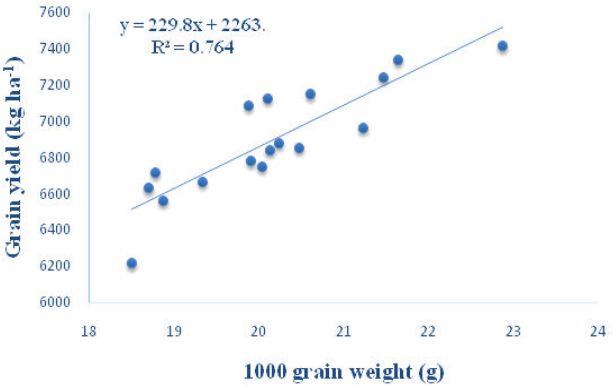

Fig. 4 : Relationship between grain yield and 1000 grain weight

On the basis of present investigation, it is concluded that, the application of 125 per cent NPK through RDF with organics (FYM and green manures) are efficient and advisable for obtaining the maximum grain yield of hybrid rice.

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