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Effect of spacing and fertilizer dose on grain yield of rice (*Oryza sativa* L.) in rice-rice cropping sequence

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ABSTRACT

The effect of optimum row spacing and fertilizer dose on grain yield of rice was studied skipping 1 row after every 3 rows at 15 cm x 15 cm spacing resulted in highest grain yield of 4.51 t ha^{-1} during the wet season and 5.27 t ha^{-1} during the dry. Most profitable rate of fertilizer application was worked out as 132, 66 and 66 kg N, P_2O_5 and K_2O ha^{-1} in the dry season while 58, 29 and 29 kg N, P_2O_5 and K_2O ha^{-1} in the wet season under rice-rice cropping sequence.

Key words: *Plant spacing, fertilizer requirement, grain yield*

Variation in plant spacing may affect crop yield (Kewat *et al*., 2002). In medium to high fertility situations, an intra-row spacing of 15 cm is considered optimum for rice (Anonymous, 1997). The spacing requirement may vary with dose of fertilizer application, variety and growing season. General recommendation of 20 cm x 15 cm spacing; and fertilizer dose of 40, 20 and 20 kg N, P_2O_5 and K_2O ha^{-1} for wet season (*Sali*), and 60, 30 and 30 kg N, P_2O_5 and K_2O ha^{-1} for dry season (*Boro*) for Assam state (Anonymous, 1997; Anonymous, 1998) may not be optimum for the high tillering variety Tapaswini (Rautaray, 2004) under rice-rice cropping sequence. Hence, a field trial was conducted to find out the optimum spacing requirement of rice variety Tapaswini in relation to dose of fertilizer application in rice-rice cropping sequence.

Field experiments were conducted during the wet seasons of 2000 and 2001 and dry seasons of 2000-01 and 2001-02 at the experimental farm of Regional Rainfed Lowland Rice Research Station, Gerua, Assam. The soil of the experimental field was silty clay loam having pH 6.0, organic carbon 1% and available 'N', 'P' and 'K' 296, 21 and 302 kg ha^{-1}, respectively. The experiment was conducted in split plot design with six plant spacings viz., 15 cm x 15 cm, 20 cm x 15 cm, 25 cm x 15 cm and 30 cm x 15 cm, along with two skipped row spacings viz., skipping one row after every three rows at 15 cm x 15 cm (15 cm x 15 cm (3:1)) and skipping two rows after every two rows at 15 cm x 15 cm (15 cm x 15 cm (2:2)) in sub-plots and fertilizer dose in the main plots. Thirty five days old seedlings were transplanted in the third week of July during the wet seasons while 45 days old seedlings were transplanted in the first week of January during dry seasons. In the wet season, recommended fertilizer dose of 40, 20 and 20 kg N, P_2O_5 and K_2O ha^{-1} was compared with no fertilizer and 80, 40 and 40 kg N, P_2O_5 and K_2O ha^{-1}. During the dry season, the recommended fertilizer doses of 60, 30 and 30 kg N, P_2O_5 and K_2O ha^{-1} was compared with no fertilizer and 120, 60 and 60 kg N, P_2O_5 and K_2O ha^{-1}. As per the recommended practice, half N, full P and K were applied as basal at final land preparation and remaining N in 2 equal splits at tillering and panicle initiation stages.

Response function was worked out using orthogonal polynomial technique. Maximized rate of fertilizer application was worked out as (–b)/(2c) from the response equation $y = a + bx + cx^2$ where y is the estimated yield at NPK level of x. However, the most profitable rate of fertilizer application (Munson and Doll, 1959) was worked out as (q/p – b)/(2c) where q is cost of one kg of NPK fertilizer (Rs 15.1) containing N: P_2O_5: K_2O @ 2: 1: 1 through urea, diammonium phosphate and muriate of potash and price of rice grain (p) as Rs 6 kg^{-1}.

An increase in panicle number m^{-2}, grains $panicle^{-1}$ and grain yield was noted with increase in fertilizer dose up to 80, 40 and 40 kg N, P_2O_5 and K_2O ha^{-1} while 1000-grain weight increased up to 40, 20 and 20 kg N, P_2O_5 and K_2O ha^{-1} (Table 1). The response function was quadratic *viz.*, $y = 3.63 + 1.073x - 0.234 x^2$ where y is grain yield in tones/ha and x is the unit dose of fertilizer (one unit was 40, 20 and 20 kg N, P_2O_5 and K_2O ha^{-1}). The maximized rate of fertilizer application was worked out to be 92, 46 and 46 kg N, P_2O_5 and K_2O ha^{-1} considering yields only. However, fertilizer recommendation should be based on profitability and hence, the most profitable rate of fertilizer application (Munson and Doll, 1959) was worked out. A fertilizer dose of 58, 29 and 29 kg N, P_2O_5 and K_2O ha^{-1} was estimated to be the most profitable rate of application in the wet season.

Regarding the effect of plant spacing, panicles $hill^{-1}$ was higher under low planting density resulting from wide row spacing and skip row arrangements. This might be due to more availability of space, nutrient, and light under wide spacing. Panicles m^{-2} was the highest and grains $panicle^{-1}$ was the lowest with the closest spacing of 15 cm x 15 cm. Test weight of grains was not influenced by plant spacing. Highest grain yield (4.51 t ha^{-1}) was recorded with the skip row spacing of 15 cm x 15 cm (3:1) and comparable yields were recorded with 20 cm x 15 cm spacing or 15 cm x 15 cm spacing. Compared with 20 cm x 15 cm and 15 cm x 15 cm (3:1), closer row spacing of 15 cm x 15 cm requires 33 % more expenditure on seed, and also proportionate cost on raising nursery and labour requirement for planting. Thus, at similar yield level, close spacing of 15 cm x 15 cm is not economical. Considering similar requirements for seedlings and labourer as well as similar grain yield with 20 cm x 15 cm and 15 cm x 15 cm (3:1), the latter spacing should be preferred for easy field operations like top dressing of fertilizers and running of cono weeder in skipped rows. Also, the skip row plantings facilitate in directing a major portion of spray volume towards the basal portion, which is required for effective control of brown plant hoppers (Moorthy and Saha, 1997). The skip row planting may also be beneficial in restricting the spread of insect vectors such as hoppers and certain pathogens (Willoeqet *et al*., 2000) by avoiding canopy contact, especially in early stage of crop growth.

Panicles m^{-2} and grain yield increased with increase in fertilizer dose up to 120, 60 and 60 kg N, P_2O_5 and K_2O ha^{-1} (Table 2). Test weight of grains and grains $panicle^{-1}$ increased up to 60, 30 and 30 kg N, P_2O_5 and K_2O ha^{-1}. Yield response to fertilizer application was quadratic viz., $y = 3.70 + 1.615x - 0.275 x^2$ where y is grain yield in tones ha^{-1} and x is the unit

Table 1. Yield attributes and yield of rice as influenced by planting geometry and fertilizer dose in wet season (Mean of 2000 and 2001)

Treatments		Panicles $hill^{-1}$	Panicles m^{-2}	Grains $panicle^{-1}$	1000 grain weight (g)	Grain yield (t ha^{-1})
Fertilizer dose (F)						
Control		6.82	199.8	116.9	17.2	3.63
40, 20 and 20 kg N, P_2O_5 and K_2O ha^{-1}		8.26	243.6	125.8	17.5	4.47
80, 40 and 40 kg N, P_2O_5 and K_2O ha^{-1}		8.75	255.7	134.1	17.5	4.84
Spacing (S)						
15 cm x 15 cm		6.34	285.5	110.3	17.2	4.38
20 cm x 15 cm		7.42	243.7	125.0	17.5	4.47
25 cm x 15 cm		8.35	222.6	128.9	17.4	4.23
30 cm x 15 cm		9.22	203.2	131.0	17.5	4.08
15 cm x 15 cm (3:1)		6.96	237.9	127.6	17.4	4.51
15 cm x 15 cm (2:2)		9.32	205.3	130.8	17.4	4.19
Mean		7.94	233.0	125.6	17.4	4.31
CD (P=0.05)	F	0.37	10.0	7.22	0.2	0.24
	S	0.46	12.6	4.4	NS	0.26
	F x S	NS	NS	NS	NS	NS

Table 2. Yield attributes and yield of rice as influenced by planting geometry and fertilizer dose in dry season (Mean of 200-01 and 2001-02)

Treatments		Panicles hill^{-1}	Panicles m^{-2}	Grains panicle^{-1}	1000 grain weight (g)	Grain yield (t ha^{-1})
Fertilizer dose (F)						
Control		8.0	235.1	98.9	16.9	3.70
60, 30 and 30 kg N, P_2O_5 and K_2O ha^{-1}		11.0	323.6	105.7	17.3	5.04
120, 60 and 60 kg N, P_2O_5 and K_2O ha^{-1}		12.1	356.0	103.9	17.4	5.83
Spacing (S)						
15 cm x 15 cm		8.2	355.2	90.8	16.9	4.94
20 cm x 15 cm		9.9	329.7	101.5	17.0	5.26
25 cm x 15 cm		10.3	275	107.7	17.2	4.91
30 cm x 15 cm		11.7	259.7	109.5	17.3	4.36
15 cm x 15 cm (3:1)		10.2	339.6	98.4	17.1	5.27
15 cm x 15 cm (2:2)		11.9	269.9	108.6	17.4	4.41
Mean		10.4	304.9	102.8	17.2	4.86
CD (P=0.05)	F	0.63	14.7	6.20	0.24	0.47
	S	0.58	11.2	4.9	NS	0.38
	F x S	NS	NS	NS	NS	NS

dose of fertilizer (one unit was 60, 30 and 30 kg N, P_2O_5 and K_2O ha^{-1}). The maximized rate of fertilizer application was worked out to be 176, 88 and 88 kg N, P_2O_5 and K_2O ha^{-1}. However, the most profitable rate of fertilizer application (Munson and Doll, 1959) for the dry season crop was worked out to be 132, 66 and 66 kg N, P_2O_5 and K_2O ha^{-1}.

Highest grain yield (5.27 t ha^{-1}) was recorded with the skip row spacing of 15 cm x 15 cm (3:1) and comparable yields were recorded with 20 cm x 15 cm, 15 cm x 15 cm and 25 cm x 15 cm spacing. Similar performance of 25 cm x 15 cm spacing with 15 cm x 15 cm (3:1) during dry season might be associated with the longer field duration and more sunshine hours available in this season (Singh *et al.*, 2003).

Thus, skipping 1 row after every 3 rows with 15 cm x 15 cm spacing was the best considering grain yield of rice and easy cultural operations in field. Most profitable rate of fertilizer application was worked out as 132, 66 and 66 kg N, P_2O_5 and K_2O ha^{-1} in the dry season while 58, 29 and 29 kg N, P_2O_5 and K_2O ha^{-1} in the wet season.

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