JOURNAL OF AGROFORESTRY AND ENVIRONMENT
ISSN 1995 - 6983
journal homepage : www.jaebd.com

NITROGEN LEVEL AND WEED CONTROL INTERACTION IN DRUM SEEDED BORO RICE

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Abstract: An experiment involving four levels of nitrogen viz. 0, 60, 90, 120 kg ha^{-1} and five weed control methods viz. no weeding, 3 hand weeding, Rifit 500EC @ 0.5 L ha^{-1}, Rifit 500EC @ 0.75 L ha^{-1}, Rifit 500EC @ 1.0 L ha^{-1} was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from December 2005 to May 2006 to evaluate the effect of nitrogen level and weed control method on the control of weeds and yield of BRRI dhan29. Among the nitrogen levels, 120 kg ha^{-1} performed as the best in terms of grain yield (5.47 t ha^{-1}) followed in order of 90 kg ha^{-1} (4.22 t ha^{-1}), 60 kg ha^{-1} (3.29 t ha^{-1}) and 0 kg ha^{-1} (2.45 t ha^{-1}). The highest grain yield (4.77 t ha^{-1}) was achieved from the application of Rifit 500EC @ 1.0 L ha^{-1} followed by 3 hand weeding (4.42 t ha^{-1}). No weeding treatment produced the lowest grain yield (2.69 t ha^{-1}). The highest N level of 120 kg ha^{-1} interacted favourably with Rifit 500EC @ 1.0L ha^{-1} to produce the highest grain yield (6.62 t ha^{-1}) which was statistically similar to that produced by the treatment combination of 120 kg N ha^{-1} and 3 hand weeding. Therefore, higher yield of BRRI dhan29 under drum seeded condition and better weed control could be achieved by the application of 120 kg N ha^{-1} and Rifit 500EC @ 1 l ha^{-1}.

Key Words: Nitrogen level, Weed control, Weed growth, Grain yield and boro rice.

Introduction

Nitrogen is the top most important nutrient and the key input for rice production. It affects the vegetative growth, development and yield of rice. An increase in the yield of rice by 70-80 percent may be obtained by proper application of nitrogen fertilizer (IFC, 1982). Many farmers use very low nitrogen and some others use very high amount. Both lower and higher nitrogen rates, no doubt are detrimental to the crop growth and development. Efficient fertilizer management gives higher yield of crop and reduces fertilizer cost (Hossain and Islam, 1986). But the dose of nitrogen fertilizer is inappropriate in most of the cases due to lack of information, and over 97% of the farmers do not follow the recommended dose (Hossain *et al*., 1981). Selection of the most appropriate level of nitrogen fertilizer is a major concern from both economic and environmental view point. Traditionally, nitrogen fertilizer is applied without considering the requirement of fertilizer at different growth stages of rice plant. So, the optimum dose of nitrogen is to be determined for production, especially for HYV rice like BRRI dhan29, which is the most popular boro rice variety of Bangladesh at present.

Weeds are considered as the major constraints among the various factors of lower yield of rice. The climate as well as the edaphic condition of Bangladesh is favourable for the growth of different weeds. So, the rice crops are usually infested heavily with weeds that reduce the grain yield by 68-100% for direct seeded *aus* rice, 16-48% for *aman* rice and 22% for modern *boro* rice (Mamun, 1990). Weed depresses the number of grains panicle^{-1} and grain yield (Smith and Shaw, 1968). Weeds compete with crops for nutrients, space and water, and thus reduce crop yield. Weeds also exert allelopathic effect on the growth of rice plant (Kasasian, 1971). Weed infestation in rice field is always subjected to agroecological conditions and growing seasons (Moody, 1989). In *boro* rice field, weeds of terrestrial, semi-aquatic and aquatic habitats grow throughout the season. Subsistence farmers of the tropics spend more time and energy on weed control than any other aspects of rice cultivation. Proper weed management ensures higher yield and facilitates the absorption of more nutrients, moisture and higher reception of solar radiation for better growth of the crop. Chemical weed control may lead to less cost of weed control. Weed control treatment has a good influence on the performance of crops. Thus the best weed control option needs to be restored to reduce weed infestation and maximize rice yield. The weed management in an integrated manner can play an important role in reducing the production cost and increasing the crop yield. Therefore, the present experiment was undertaken to identify the most suitable combination of nitrogen level and weed control method for better weed control and higher yield of BRRI dhan29.

Materials and Methods

An experiment was conducted at the Agronomy Filed Laboratory, Bangladesh Agricultural University, Mymensingh from November 2005 to May 2006 with a view to findings out the effect of nitrogen level and weed control method on the performance of *boro* rice cv. BRRI dhan29 under direct wet seeding method by using drum seeder. The experiment consisted of four levels of nitrogen viz. 0, 60, 90 and 120 kg ha^{-1}, and five weed control methods viz. no weeding, 3 hand weeding(at 15, 30 and 45 days after sowing), Rifit 500EC @ 0.5 L ha^{-1}, Rifit 500EC @ 0.75 L ha^{-1} and Rifit 500EC @ 1 L ha^{-1}. Rifit is a systemic pre-emergence herbicide and selective for rice. Its common name is pretilachlor. The experiment was laid out in a randomized complete block design with there replications. The unit plot size was 4m × 2.5m and total number of unit plot was 60. The experimental field is located at 24^{0}75' N latitude and 90^{0}50' E longitude at an altitude of 18 m above sea level. The experimental site belongs to the Old Brahmaputra Floodplain Agro-ecological Zone: AEZ-9 (UNDP and FAO, 1988). The land was medium high with silty loam texture, low fertility level and slightly acidic in nature (pH = 6.8). Soil organic carbon and total nitrogen were recorded 0.89% and 0.16%, respectively. The average temperatures recorded in different months during the experimental period were 20.10^{o}C (December), 18.10^{o}C (January), 21.87^{o}C (February), 25.09^{o}C (March), 26.45^{o}C (April), 28.09^{o}C (May), while the total month wise rainfall

were recorded as 18.0, 3.4, 26.6, 83.6, 146.6 and 413.2 mm, respectively. The average relative humidity ranged from 74 to 83% during the experimental period. The experimental plot was fertilized with TSP, MP, Gypsum and Zinc sulphate at the rate of 130, 120, 70, 10 kg ha^{-1} as basal doses (BRRI, 1999). Urea was top dressed at 30, 45 and 60 days after sowing (BRRI, 2003) as per treatment specification. Sprouted seeds were air dried for 8 hours under shade for proper separation of seeds and then sown by a drum seeder on 22 December, 2005 in the well leveled plots. Intercultural operations were done as and when necessary. Five hills were selected randomly from each unit plot excluding border rows before final harvest for data collection. Weeds were collected from the peripheral sampling area by using a plant quadrate of 0.50m × 0.50m size. The weeds inside each quadrant were uprooted, cleaned and dried first in sun and then in an electrical oven for 72 hours at a temperature of 80° C. The dry weight was then taken by an electric balance and expressed in gm $^{-2}$. For collecting yield data the central $1m^2$ area was harvested when 90% of the grains became golden yellow in color. The harvested crop was then threshed and dried properly. The weights of grain and straw were recorded (at 14% moisture content) and converted into t ha^{-1}. Data were analysed using the "Analysis of Variance Technique" and mean differences were adjudged by Duncan's Multiple Range Test.

Results and Discussion

Effect of N level

Nitrogen level significantly influenced weed dry weight (Table 1). The highest weed dry weight (228.12 g m^{-2}) was recorded under control treatment (no nitrogen), while the minimum one (121.14 g m^{-2}) was noticed with the highest level of nitrogen (120 kg ha^{-1}). Nitrogen level significantly influenced the grain yield of BRRI dhan29 (Table 1). The highest grain yield (5.47 t ha^{-1}) was obtained from the application of 120 kg N ha^{-1}. The levels of 90 kg ha^{-1} and 60 kg ha^{-1} ranked the second (4.22 kg ha^{-1}) and third (3.29 kg ha^{-1}) respectively, in terms of grain yield. The highest number of effective tillers m^{-2} (421.22), grains $panicle^{-1}$ (95.71) and thousand grain weight (22.78 g) mostly contributed to the highest grain yield which was achieved by the application of 120 kg N ha^{-1}. On the other hand, the lowest grain yield (2.4 t ha^{-1}) was recorded from control (no nitrogen), which was the consequence of lowest number of effective tillers m^{-2} (289.29), grains $panicle^{-1}$ (79.54) and thousand grain weight (22.08g). Chopra and Chopra (2000), BINA (1996), Chander and Pandey (1996), Kumar *et al.* (1995) also observed that rice yield increased gradually with an increase of N level and was maximum at 120 kg N ha^{-1}. Plant height and straw yield also were significantly influenced by nitrogen level (Table 1). The highest straw yield (7.16 t ha^{-1}) and the tallest plant (91.86 cm) were found with the highest N level (120 kg ha^{-1}). The lowest straw yield (3.11 t ha^{-1}) and the shortest plant (69.69 cm) were recorded from the crop receiving no nitrogenous fertilizer. Srivastava *et al.* (1987) also reported similar findings.

Effect of weed control method

Twelve weed species collected from the experimental field were identified as *Echinochloa crus-galli, Marshes quadrifolia, Digitaria sanguinalis, Echinochloa colonum, Paspalum commersoni, Cyprus iria, Scirpus maritimus, Cyperus difformis, Monochoria vaginalis, Lindernia anagalis, Paspalum distichan* and *Fimibristylis miliacea* belonging to five different families e.g. Graminae, Cyperaceae, Marsiliaceae, Scorphulariaceae and Pontederiaceae. Among all the weeds grasses were major in number, followed by sedges. The broad leaf weed were less in number. Most of the identified weeds were annual except *Paspolum distichum* and *Monochoria vazinalies*.

Weed control method exerted significant influence on weed dry weight (Table 1). The highest weed dry weight (217.63 g m^{-2}) was recorded under unweeded condition, and the least weed growth (124.66 g m^{-2}) was found when weed was controlled by using Rifit 500EC @ 1.0 Lha^{-1}. BRRI (2005) also reported Rifit 500 EC as the most effective herbicide to suppress weed growth in rice field when applied @ 1.0 Lha^{-1}. Weed control method significantly affected rice grain yield. The highest grain yield (4.77 t ha^{-1}) was achieved with Rifit 500EC @ 1.0 L ha^{-1} followed by in order of (4.42 t ha^{-1}), (3.99 t ha^{-1}), (3.39 t ha^{-1}) and (2.69 t ha^{-1}), respectively achieved by 3 hand weeding, Rifit 500EC @ 0.75 Lha^{-1}, Rifit 500EC @ 0.5 Lha^{-1} and no weeding (Table 1). The highest number of effective tillers m^{-2} (441.1), grains $panicle^{-1}$ (92.38) and 1000-grain weight (22.83 g) mostly contributed to the highest grain yield (4.77 t ha^{-1}) produced by BRRI dhan 29 with the weed control option of Rifit 500EC @ 1.0 Lha^{-1}. On the other hand, the lowest grain yield (2.69 t ha^{-1}) recorded under unweeded condition was the consequence of lowest number of effective tillers m^{-2} (235.5), grains $panicle^{-1}$ (82.34) and 1000-grain weight (22.06 g). BRRI (2005) also observed the highest grain yield of rice from the application of Rifit 500EC @ 1.0 Lha^{-1} for controlling weeds in drum seeded rice. Control of weeds by hand weeding three times produced the second highest grain yield (4.42 t ha^{-1}) which was mostly the outcome of higher number of effective tillers m^{-2} (431.7) along with greater number of grains $panicle^{-1}$ (90.11) and higher 1000-seed weight (22.45 g). Saxena and Viashya (1993) also reported in the same tune. Application of Rifit 500EC @ 1.0 Lha^{-1} produced the tallest plant (87.49 cm) closely followed by 3 hand weeding (84.66 cm), while the shortest one (78.31 cm) was recorded when no weeding was done. Straw yield followed the similar trend as found in case of plant height producing highest value (6.16 t ha^{-1}) with Rifit 500EC @ 1.0 Lha^{-1}, closely followed by 3 hand weeding (5.73 t ha^{-1}), and the lowest one (3.45 t ha^{-1}) was recorded under unweeded condition. The highest straw yield recorded with the weed control method of Rifit 500EC @ 1.0 Lha^{-1} may be the consequence of highest plant height and highest number of tillers m^{-2}.

Table 1. Effect of level of N and weed control method on weed dry weight and the performance of boro rice cv. BRRI dhan29

Nitrogen level	Dry weight of weed (g m^{-2})	Plant height (cm)	Effective tillers m^{-2} (no.)	Non-effective tillers m^{-2}	Grains panicle^{-1} (no.)	Un-filled grains m^{-2}(no.)	1000 grains wt. (g)
N_0	228.12a	69.69d	289.29b	19.69bc	79.54d	462.7a	22.08b
N_1	194.16b	83.23c	360.81c	20.22ab	83.77c	442.9c	22.31ab
N_2	135.01c	87.20b	398.83b	20.91a	90.35b	453.3b	22.66a
N_3	121.14d	91.86a	421.22a	19.42c	95.71a	450.8bc	22.78a
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.05
$\bar{Sx}$	3.660	0.436	3.315	0.245	0.6768	2.933	0.157
Weed control method							
W_0	217.63a	78.31e	235.5d	19.35b	82.34d	495.4a	22.06b
W_1	184.19c	84.66b	431.7a	19.41b	90.11b	435.6c	22.45ab
W_2	183.70b	81.55d	357.9c	19.87b	84.15d	460.4b	22.30ab
W_3	173.85b	82.99c	371.5b	19.65b	87.74c	455.1b	22.64a
W_4	124.66d	87.49a	441.1a	22.02a	92.38a	415.5d	22.83a
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.05
$\bar{Sx}$	4.092	0.487	3.706	0.273	0.756	3.279	0.175

Figures in a column having similar latter (s) do not differ significantly as per DMRT.

Where,

N_0 = 0 kg N ha^{-1}
N_1 = 60 kg N ha^{-1}
N_2 = 90 kg N ha^{-1}
N_3 = 120 kg N ha^{-1}

W_0 = No weeding (control)
W_1 = 3 hand weeding
W_2 = Rifit 500EC @ 0.5L ha^{-1}
W_3 = Rifit 500EC @ 0.75L ha^{-1}
W_4 = Rifit 500EC @ 1.0 L ha^{-1}

Effect of interaction

The interaction between effect of nitrogen level and weed control was significant for the dry weight of weed (Table 2). The highest weed dry weight (298.92 g m^{-2}) was registered with the interaction between no nitrogen × no weeding while the lowest weed dry weight of 100.51 g m^{-2} was recorded with the combination of 120 kg N ha^{-1} and Rifit 500EC @ 1.0 Lha^{-1}. Nitrogen level and weed control interaction significantly influenced all the yield contributing characters (except 1000-grain weight) and yield of *boro* rice cv. BRRI dhan29 (Table 2). Results revealed that the highest level of nitrogen i.e. 120 kg N ha^{-1} interacted favourably with the weed control method of Rifit 500EC @ 1.0 l ha^{-1} to produce the highest grain yield (6.62 t ha^{-1}) which was statistically similar to that produced by the interaction effect of 120 kg N ha^{-1} × 3 hand weeding (6.41 t ha^{-1}). Yield contributing characters like number of effective tillers m^{-2}, grains pancile^{-1} and 1000-grain weight favoured the interaction of 120 kg N ha^{-1} × Rifit 500EC @ 1.0 Lha^{-1} or 3 hand weeding to produce the highest grain yield. The second highest grain yield of 5.51 t ha^{-1} was obtained from the interaction between 120 kg N ha^{-1} and Rifit 500EC @ 0.75 Lha^{-1} which was statistically identical with treatment combination of 90 kg N ha^{-1} and Rifit 500 EC @ 1.0 Lha^{-1} (5.24 t ha^{-1}). The lowest grain yield of only 1.50 t ha^{-1}, on the other hand, was produced when the crop received neither nitrogen nor any weed control method (no nitrogen × no weeding) for which the lowest no. of effective tillers m^{-2} (196.5), lowest no. of grains panicle^{-1} (71.90) and the highest no. of unfilled grains m^{-2} (560.00) were responsible. The highest straw yield (8.82 t ha^{-1}) was given by the interaction of 120 kg N ha^{-1} × Rifit 500EC @ 1.0 l ha^{-1} closely followed by the treatment combination of 120 kg N ha^{-1} and 3 hand weeding (8.32 t ha^{-1}), and the lowest one (1.92 t ha^{-1}) was produced by the interaction of 0 kg N ha^{-1} × no weeding (control). Straw yield was mostly contributed by plant height and no. of tillers m^{-2} which was followed the similar trend as found in case of straw yield.

Table 2. Interaction effect of nitrogen level and weed control method on weed dry weight and the performance of *boro* rice (BRRI dhan29)

Interaction (nitrogen level × weed control) method	Dry weight of weed (g m^{-2})	Plant height (cm)	Effective tillers m^{-2} (no.)	Non-effective tillers m^{-2}	Grains $panicle^{-1}$ (no.)	Un-filled grains m^{-2} (no.)	1000 grains wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
N_0W_0	298.92a	65.23k	196.5j	19.11efgh	71.90i	560.0a	21.87	1.50j	1.92k
N_0W_1	191.92e	71.37i	333.9g	18.01h	84.02f	440.4efg	22.08	3.11g	3.98h
N_0W_2	256.28b	67.58jk	292.7h	19.97cdefg	74.96hi	441.8ef	22.04	2.03i	2.54j
N_0W_3	227.57c	68.41j	279.4hi	19.25efgh	81.81f	451.0de	22.33	2.48h	3.19i
N_0W_4	165.91fg	75.85h	344.0g	22.10a	85.00ef	420.4g	22.06	3.12g	3.92h
N_1W_0	257.62b	79.48g	212.3j	18.41fgh	80.28fg	461.9cde	22.13	2.49h	3.21i
N_1W_1	180.75ef	85.14f	432.9d	19.31efgh	89.22de	424.8fg	22.21	3.09g	4.10gh
N_1W_2	207.72cd	80.42g	339.5g	21.22abcd	76.46gh	455.8de	22.00	2.88g	3.79h
N_1W_3	200.01de	82.28g	375.4f	20.35abcbe	81.92f	450.5de	22.15	3.88de	4.98be
N_1W_4	124.72hi	88.85de	444.0d	21.79ab	90.97cd	421.3fg	23.06	4.11d	5.29d
N_2W_0	157.51fg	80.13g	258.4i	21.62abc	85.04ef	479.1bc	22.03	3.11g	3.34h
N_2W_1	110.61i	89.05cde	467.2c	21.25abcd	92.11bcd	448.9de	23.05	5.11c	6.56c
N_2W_2	143.27gh	87.07ef	391.7ef	20.19bcdef	89.05de	483.5b	22.18	3.51f	4.47fg
N_2W_3	156.18fg	89.21cde	400.6e	19.37efgh	90.10d	454.5de	22.99	4.11d	5.30d
N_2W_4	107.51i	90.57bcd	476.4bc	22.11a	95.47abc	400.2h	23.04	5.24bc	6.63c
N_3W_0	156.50fg	88.38de	274.8hi	18.23gh	92.12bcd	480.6bc	22.22	3.68ef	4.75ef
N_3W_1	109.50ij	93.06ab	493.0ab	19.06efgh	95.08abc	428.4fg	22.45	6.41a	8.32b
N_3W_2	127.50hi	91.11bcd	407.5e	18.10h	96.12ab	460.4cde	22.98	5.14c	6.97c
N_3W_3	111.66ij	92.06abc	430.6d	19.65defgh	97.15a	464.3bcd	23.08	5.51b	6.95c
N_3W_4	100.51j	94.71a	500.2a	22.08a	98.07a	420.3g	23.16	6.62a	8.82a
Level of significance	0.01	0.05	0.01	0.01	0.01	0.01	NS	0.01	0.01
$S\bar{x}$	8.184	0.9747	7.413	0.546	1.513	6.559	0.3512	0.1095	0.1472

Figures in a column having similar latter (s) do not differ significantly as per DMRT.

NS = Not significant

Where,

N_0 = 0 kg N ha^{-1}
N_1 = 60 kg N ha^{-1}
N_2 = 90 kg N ha^{-1}
N_3 = 120 kg N ha^{-1}

W_0 = No weeding (control)
W_1 = 3 hand weeding
W_2 = Rifit 500EC @ 0.5 L ha^{-1}
W_3 = Rifit 500EC @ 0.75L ha^{-1}
W_4 = Rifit 500EC @ 1.0L ha^{-1}

Conclusion

Results of the present study reveal that both nitrogen level and weed control method and their interaction have significant influence on weed growth and yield performance of boro rice. Therefore, higher yield of drum seeded *boro* rice cv. BRRI dhan29 as well as better weed control could be achieved by applying 120 kg N ha^{-1} along with Rifit 500EC @ 1.0 L ha^{-1}. Hand weeding three times may also be considered as a viable non-chemical weed control option from environmental view point. However, since BRRI dhan29 responded upto the highest nitrogen level of 120 kg ha^{-1}, it does not ventilate any clue for deciding actual nitrogen requirement of that particular variety. Therefore, further studies considering nitrogen level higher than 120 kg N ha^{-1} should be carried out to arrive at a concrete decision regarding the nitrogen requirement of BRRI dhan29 under drum seeded condition.

References

BINA (Bangladesh Institute of Nuclear Agriculture). 1996. Annual Report for 1993-94. Bangladesh Institute Nucliear Agriculture, Mymensingh. p175.

BRRI. 1999. *Dhan Chaser Kisu Lagshoi Projukti* (In Bangla). Bangladesh Rice Research Institute, Joydebpur, Gazipur, Bangladesh. p 3.

BRRI. 2003. Annual Internal Review for 2002-2003, held on 19-23 October, 2003. Bangladesh Rice Research Institute, Adaptive Res. Div., Joydebpur, Gazipur. pp 13-15.

BRRI. 2005. Annual Internal Review for 2004-2005, held on 18-22 December, 2005. Bangladesh Rice Res. Inst., Adaptive Res. Div., Joydebpur, Gazipur, pp 14-19.

Chander, S. and Pandey, J. 1996. Effect of herbicide and nitrogen on yield of scented rice (*Oryza sativa*) under different rice cultures. Indian Journal Agronomy 41(2):209-214.

Chopra, N.K. and Chopra, N. 2000. Effect of row spacing and N level on growth, yield and seed quality of scented rice (*Oryza sativa*) under transplanted conditions. Indian Journal Agronomy 45(2):304-308.

Hossain, S.M.A. and Islam, M.S. 1986. Fertilizer management in Bangladesh. Adv. Agron. Res. Joydebpur, Gazipur. pp 48-54.

Hossain, S.M.A., Satter, N. and Ahmed, J.U. 1981. Bench Mark Survey Kanhar Cropping System Research Site. Graduate Training Institute and Department of Agronomy, Bangladesh Agril. Univ., Mymensingh.

IFC. 1982. FAO/FAIL working parts on the economics of fertilizer use. Fert. Corres. 23(1): 7-10.

Kasasian, L. 1971. Weed Control in the Tropics. CRC Press, Cleveland, Ohio, USA p 307. In Proc: Conf. Weed Control in Rice. Intl. Rice Res. Inst., Los Banos, Philippines. P 32.

Kumar, S.R., Reddy, M.R., Reddy, T.M.M. and Reddy, B.B. 1986. Nitrogen management in direct seeded and transplanted rice. Indian Journal Agronomy 31(1): 100-101.

Mamun, A.A. 1990. Agro-ecological studies of weeds and weed control in a flood prone village of Bangladesh. Japan Intl. Co-operation Agency, Dhaka, Bangladesh. JSARD Pub. No. pp 17. 22-29 and 165.

Moody, K. 1989. Weeds reported in rice in South East Asia. Intl. Rice Res. Inst., Los Banos, Laguna, Philippines. pp. 87-100.

Saxena, A. and Viashya, R.D. 1993. Effect of methods of weed control on the yield of upland drilled rice and associated weeds. Integrated weed management for sustainable agriculture. In Proc: Indian Soc. Weed Sci., Intl. Symp., Hisar, India. Vol. No. 3, pp 40-42.

Smith, R.J. and Shaw, W.C. 1968. Weeds and their control in rice production. Agric. Res. Service, USDA. Agric. Handbook No. 292. pp 12-19.

Srivastava, S.K., Singh, J.R. and Chandrawanshi, B.R. 1987. Nitrogen management for increasing N efficiency in transplanted rice. Intl. Rice Res. Newsl. 12:4-51.

UNDP and FAO (United Nations Development Program and Food and Agricultural Organization). 1988. Land Resources Appraisal of Bangladesh for Agricultural Development. Agro-ecological Regions of Bangladesh, Report 2, FAO, Rome. p 6.