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PERFORMANCE OF DIFFERENT CROPS PRODUCTIVITY ENHANCEMENT THROUGH ADAPTATION OF CROP VARIETIES AT CHARLAND IN BANGLADESH

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Abstract

Charland that are emerged as islands within the river channel or as attached land to the riverbanks as a result of erosion and accretion. In crop production systems, screening of adaptable crop varieties for charland is necessary to address the climate change issues. Hence, five separate experiments were conducted at charland of the Padma River in Kushtia district during November 2012 to May 2013 to select suitable varieties of lentil, hybrid maize, soybean, potato and mustard for increasing crop productivity. The experiment comprised of four lentil varieties viz. BARI Masur-4, BARI Masur-5, BARI Masur-6 and a local cultivar; four hybrid maize varieties namely BARI Hybrid maize-5, BARI Hybrid maize-7, BARI Hybrid maize-9 and Pacific-11; three soybean varieties like BARI Soybean-5, BARI Soybean-6 and Shohag; four potato varieties viz., BARI Alu-7, BARI Alu-8, BARI Alu-31 and Belgium; and five mustard varieties viz., BARI Sarisha-11, BARI Sarisha-13, BARI Sarisha-14, BARI Sarisha-15 and BARI Sarisha-16 were evaluated separately in five trials for their adaptation in charland. Among the studied crops, lentil var. BARI Masur-6, maize var. BARI Hybrid maize-9, soybean var. BARI Soybean-6, potato var. BARI Alu-7 and mustard var. BARI Sarisha-11performed better in the charland under climate change situation in Bangladesh.

Keywords: Crop Productivity, Adaptation, Crop Varieties, Charland, Climate Change.

Introduction

Climate change refers to a change of climate that is attributed directly or indirectly to human activities. Bangladesh is extremely vulnerable to climate change impacts because of its geographical location, high population density, high levels of poverty, and the dependence of many livelihoods on climate-sensitive sectors, particularly agriculture and fisheries. Climate change will result in greater variation in weather patterns or weather events such as irregular floods (Mirza, 2002), increase in droughts (Amin *et al*., 2008), too much rainfall in monsoon and too little rainfall in the dry season (Tanner *et al*., 2007), frequent cyclone and storms (Salauddin and Ashikuzzaman, 2012), gradual rise in average temperature (Islam *et al*., 2008), increase in intrusion of saline water (Ali *et al*.,

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2014), rise in sea-levels (Islam, 1994) as well as frequent river bank erosion and formation of char land (Ahmed, 2006) in Bangladesh. In crop production systems, screening and introducing adaptable crop varieties for char land eco-system would be needed to address the climate change issues.

Chars are the lands that emerge as islands within the river channel or as attached land to the riverbanks as a result of the dynamics of erosion and accretion in the rivers of Bangladesh (Sattar and Islam, 2010). Char land areas are estimated to be 0.72 million hectares in Bangladesh which is about 5% of the country area and about 6.5 million people (5% of the country's population) live there (EGIS, 2000). It is mentionable that 64 to 97% of the char areas are cultivable (Ahmed *et al*., 1987). The Char dwellers mainly depend on agriculture and agriculture related activities. Other opportunities such as off farm activities are marginal there. So, to increase cropping intensity and crop productivity in stress prone areas like charland is urgently needed. Generally farmers in char lands cultivate potato, hybrid maize, sweet potato, mustard, lentil, grasspea, field pea, blackgram, chilli, proso millet, muskmelon, bitter gourd, sweet gourd, groundnut, sugarcane etc. in *rabi* season and *aus* rice, jute, foxtail millet and sesame etc. in *kharif* season with local variety and low management practices. As a result, much lower yield is achieved in char areas (Islam *et al*., 2012). Introduction of new crops with modern varieties (MV) along with appropriate agronomic management practices would boost up the farm productivity that will reduce the poverty level of resource poor farmers of that area.

Improvement of crop productivity and livelihood pattern as well as enhancement of food security of all char land people is very cumbersome in relation to climate change situation. As such char area under Bheramara Upazilla in Kushtia district (Agro-ecological zone 11) was selected as the experimental site. Information relating varietal adaptability of different crops like lentil, mustard, potato, hybrid maize and soybean in the study areas of char land eco-system under climate change situation is meagre. Therefore, five separate experiments were conducted to select adaptable varieties of aforesaid crops for charland of the Padma River under Kushtia district to increase crop productivity in that area.

Materials and Method

Five separate experiments were conducted at Golapnagar char of the Padma River under Bheramara Upazilla in Kushtia district during the period from November 2012 to May 2013. The soil of the experimental area was silty loam in texture belonging to Calcareous Dark Grey Foodplain soil (Agro-ecological zone 11). Soil samples from experimental area were collected from 0-20 cm depth prior to set up experiments and analyzed in the laboratory. Results of soil analysis are presented in Table 1. The soil was neutral in soil reaction, low in organic matter and available P content. Total N and available S content were very low but medium in exchangeable K and available B content. Each experiment was laid out in randomized complete block design with five disperse replications. The unit plot size was 8m x 10m.

Table 1. Chemical properties of experimental soil

Location	pH	OM (%)	Total N (%)	Available P (µg/ml)	Exchange-able K (meg/100g)	Available S (µg/ml)	Available B (µg/ml)
Golapnagar char	7.04	1.14	0.070	7.33	0.190	5.10	0.285
Status of soil		L	VL	L	M	VL	L

OM= Organic matter, L= low, VL= very low, M= medium.

Experiment 1

Three high yielding lentil varieties viz. BARI Masur-4, BARI Masur-5 and BARI Masur-6 were tested for their adaptability and compared with local variety in charland eco-system under climate change situation. The crop received total rainfall of 13 mm during growing period. The average maximum and minimum air temperatures during crop period were 26.9 ºC and 14.1 ºC, respectively. The initial soil moisture content at the time of sowing was 20-22% by weight. Seeds of lentil were sown 30 cm apart in solid line on 12 November, 2012. Fertilizers @ 20-36-25 kg/ha of NPK (FRG, 2012) were applied at the time of final land preparation in the form of urea, triple super phosphate and muriate of potash. One hand weeding was done at 25 days after sowing (DAS). The crop was harvested on 03 March, 2013 (111 DAS).

Experiment 2

Three BARI developed hybrid maize varieties viz. BARI Hybrid maize-5, BARI Hybrid maize-7 and BARI Hybrid maize-9 were evaluated for their adaptability and compared with Pacific-11(an imported maize hybrid) in char land under climate change situation. The crop received total rainfall of 156 mm during growing period. The average maximum and minimum air temperatures during crop period were 28.9 ºC and 20.5 ºC, respectively. The initial soil moisture content at the time of sowing was 19-21% by weight. Seeds were sown on 27 November in 2012 with 60 cm x 20 cm spacing. The crop was fertilized with 250-55-110-50-5 kg/ha of NPKSZn (FRG, 2012). One third N and full amount of other fertilizers were applied at the time of final land preparation in the form of urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate. Rest amount of N were applied in two equal splits at 30 and 60 DAS followed by irrigations. One hand weeding and earthing up was done at 20 and 40 DAS, respectively. The crop was harvested at maturity stage on 26 April, 2013 (150 DAS).

Experiment 3

Three soybean varieties viz. BARI Soybean-5, BARI Soybean-6 and Shohag were evaluated for their adaptability in char land under climate change situation. The initial soil moisture content at the time of sowing was 18-20% by weight. Seeds were sown with a spacing of 30 cm ×5 cm on 22 January, 2013. The crop received total rainfall of 295 mm during growing period. The average maximum and minimum air temperatures during crop period were 30.6 ºC and 18.4 ºC, respectively. Crops were fertilized with 28-35-60-20 kg/ha of NPK (FRG, 2012) as urea, triple super phosphate, muriate of potash, and gypsum, respectively. All fertilizers were applied during final land preparation as basal. Two irrigations were applied at 30 and 60 DAS. One hand weeding was done at 25 DAS. The crop was harvested at maturity stage on 17 May, 2013 (115 DAS).

Experiment 4

Three BARI developed potato varieties viz. BARI Alu-7 (Diamant), BARI Alu-8 (Cardinal) and BARI Alu-31 (Sagita) were evaluated for their adaptability and compared with Belgium (farmers practicing variety) in char land under climate change situation. The initial soil moisture content at the time of sowing was 22-24% by weight. Potato tubers were planted on 20 November, 2012 with 60 cm x 25 cm spacing. The crop received total rainfall of 13 mm during growing period. The average maximum and minimum air temperatures during crop period were 26.0 ºC and 13.9 ºC, respectively. The crop was fertilized with 198-44-194-24-6-1.2 kg/ha NPKSZnB (FRG, 2012). Half of N and full dose of other fertilizers were applied as basal in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively. The remaining N was top dressed at 30 days after potato planting followed by irrigation. Earthing up of potato and other intercultural operations were done as and when required. The crop was harvested on 25 February, 2013 (97 DAS).

Experiment 5

Five HYV mustard varieties viz., BARI Sarisha-11, BARI Sarisha-13, BARI Sarisha-14, BARI Sarisha-15 and BARI Sarisha-16 were tested for their adaptability in char areas under climate change situation. The crop received total rainfall of 14 mm during growing period. The average maximum and minimum air temperatures during crop period were 26.2 ºC and 14.1 ºC, respectively. Mustard was grown with 160-46-120-36-4 kg/ha NPKSZn (FRG, 2012). Half of nitrogen and full quantity of PKSZn were applied as basal in the form of urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate, respectively. The initial soil moisture content at the time of sowing was 22-22% by weight. Seeds of each variety were sown in 30 cm apart solid line on 20 November, 2012. Remaining half of nitrogen was applied at the time of flower initiation (20-25 DAS) as top dressing followed by irrigation. The crop was kept weed free up to 20 DAS by two hand weedings at 10 and 20 DAS. Harvesting of different varieties was done from 12 February to 02 March, 2013 depending on maturity.

In each experiment, data on plant population per square metre were recorded from randomly selected three places and on yield contributing characters from randomly selected 10 plants in each plot. Yield was taken from whole plot. Collected data were analyzed statistically and the means were adjudged using Least Significant Difference (LSD) test at 5% level of significance.

Results and Discussion

Experiment 1

Yield and yield contributing characters of lentil varieties are presented in Table 2. Number of days required from sowing to harvesting (108-111 days) of different high yielding variety (BARI Masur-4, BARI Masur-5, BARI Masur-6) and local variety of lentil did not differ significantly. However, BARI developed lentil varieties required 2-3 days more than local variety. Plant population/m^2 of different lentil varieties were statistically similar and numerically higher in local variety. Number of pods/plant of different lentil varieties varied significantly. The maximum number of pods/plant (67) was recorded in BARI Masur-6, which was statistically identical to BARI Masur-5 (59). The lowest number of pods/plant was observed in local variety. The highest number of pods/plant in BARI Masur-6 was contributed due to profuse pod setting. Number of seeds/pod between BARI Masur-6 (1.9) and BARI Masur-5 (1.8) was statistically at par. The minimum number of seeds/pod was obtained from local variety (1.2). Thousand seed weight i.e. seed size is a genetically controlled trait of lentil. The maximum 1000-seed weight was recorded in BARI Masur-6 (22.5 g) which was statistically identical with BARI Masur-4 (21.4 g) and BARI Masur-5 (21.9g). The lowest 1000-seed weight (18.0 g) was observed in local variety. Seed yield of lentil varieties also differed significantly (Table 2). The maximum seed yield was recorded in BARI Masur-6 (1042 kg/ha) and it was statistically similar with BARI Masur-5 (1032 kg/ha) and BARI Masur-4 (1019 kg/ha). Local lentil variety produced the lowest seed yield (875 kg/ha). Seed yield of BARI developed lentil varieties was 16.5 – 19.1% higher than local lentil variety. The higher seed yield in BARI developed lentil varieties were attributed to higher pods/plant, seeds/pod and 1000- seed weight. Similar findings were obtained by Islam *et al.* (2010). The results revealed that high yielding variety of lentil developed by BARI performed better in char land eco-system under climate change situation.

Table 2. Seed yield and yield contributing characters of lentil varieties at char land eco-systems under climate change situation (Kushtia, 2012-13)

Varieties	Days to maturity	Plant/ m^2 (no.)	Pods/ plant (no.)	Seeds/ pod (no.)	1000 seed wt. (g)	Seed yield (kg/ha)	Yield increase over local (%)
BARI Masur- 4	110	159	54	1.7	21.4	1019	16.5
BARI Masur- 5	111	169	59	1.8	21.9	1031	17.8
BARI Masur- 6	111	154	67	1.9	22.5	1042	19.1
Local variety	108	177	43	1.2	18.0	875	-
LSD $_{(0.05)}$	NS	NS	6	0.1	1.2	150	-
CV (%)	13	11	8	6	4	11	-

NS = Not significant

Table 3. Grain yield and yield contributing characters of hybrid maize varieties at char land eco-systems under climate change situation (Kushtia, 2012-13).

Varieties	Plants /m^2 (no.)	Cobs/ plant (no.)	Grains/ cob (no.)	1000 grain wt.(g)	Grain yield (t/ha)	Yield increase over Pacific 11 (%)
BARI Hybrid maize-5	7.96	1.0	410	312.6	7.14	1.4
BARI Hybrid maize-7	8.24	1.2	403	334.3	9.32	32.4
BARI Hybrid maize-9	8.24	1.2	431	345.0	10.29	46.2
Pacific-11	8.24	1.0	392	311.5	7.04	-
LSD $_{(0.05)}$	NS	0.1	23	10.8	1.18	-
CV (%)	8.2	6	4.1	2.4	10.1	-

NS = Not significant

Experiment 2

Yield and yield components of hybrid maize varieties except plant population/m^2 differed significantly (Table 3). Plant population/m^2 in all maize hybrids was identical but it was slightly lower in BARI Hybrid maize-5 (7.96) due to lower germination of seed. Similar number of cobs/plant (1.2) was recorded in BARI Hybrid maize-7 and BARI Hybrid maize-9 while lower cobs/plant (1.0) was obtained from BARI Hybrid maize-5 and Pacific-11. The maximum number of grains/cob was recorded in BARI Hybrid maize-9 (431) which was identical with BARI Hybrid maize-5 (410). The lowest number of grains/cob (392) was found from Pacific-11 but at par with BARI Hybrid maize-7 (403) and BARI Hybrid maize-5 (410). Thousand grain weight of maize hybrids is a genetically control parameter but it may be changed through changing the environment of growing place. The maximum 1000-grain weight was obtained from BARI Hybrid maize-9 (345.0g) which was at par with BARI Hybrid maize-7 (334.3g). Grain size of Pacific -11 was minimum (311.5g) followed by BARI Hybrid maize-5 (312.6g). The highest grain yield was recorded in BARI Hybrid maize-9 (10.29 t/ha) and it was statistically identical with BARI Hybrid maize-7 (9.32 t/ha) and these two varieties produced 46.2% and 32.4% higher yield, respectively than Pacific-11 (an imported maize hybrid). On the contrary, yield performance of BARI Hybrid maize-5 (7.14 t/ha) and Pacific-11 (7.04 t/ha) was similar in char areas under climate change situation. The higher grain yield of BARI Hybrid maize-9 and BARI Hybrid maize-7 was contributed to the cumulative effect of yield attributes. Similar findings were reported by Begum *et al.* (2010). The results revealed that BARI Hybrid maize-9 exhibited the best performance in char land areas under climate change situation. Alternately, BARI Hybrid maize-7 could be grown for getting higher grain yield as compared to Pacific-11. Though BARI Hybrid maize-5 is a quality protein variety but failed to show higher yield due to lower cobs/plant and 1000- grain weight and can not be suitable in charland area.

Table 4. Seed yield and yield contributing characters of soybean varieties at char land eco-systems under climate change situation (Kushtia, 2012-13).

Varieties	Days to maturity	Plant/m^2 (no.)	Pods/ plant (no.)	Seeds/ pod (no.)	1000 seed wt. (g)	Seed yield (kg/ha)
BARI Soybean-5	113	35.6	48.8	2.5	141.0	1531
BARI Soybean-6	115	35.9	57.2	2.8	146.0	2099
Sohag	113	36.2	54.3	1.9	107.3	1002
LSD $_{(0.05)}$	NS	NS	4.5	0.1	3.2	185
CV (%)	8.9	9.3	7.2	3.5	2.1	10.3

Experiment 3

Plant population/m^2, number of pods/plant, seeds/pod, 1000-seed weight and seed yield/ha of soybean varieties are presented in Table 4. Plant population/m^2 and days to maturity of different soybean varieties did not differ significantly due to uniform planting system. Number of pods/plant, seeds/pod and 1000-seed weight of soybean varieties varied significantly in char land eco-system under climate change situation (Table 4). BARI Soybean-6 produced profuse pods, as a result, the highest number of pods/plant (57.2) was recorded in this variety and it was statistically identical with Sohag (54.3). BARI Soybean-5 produced minimum number of pods/plant (48.8). Seeds/pod is a genetically controlled trait and sometimes it may be changed by environmental influence. The highest number of seeds/pod (2.8) was obtained from BARI Soybean-6 and the lowest

(1.9) from Sohag. Thousand seed weight followed a similar trend to seeds/pod. Seed yield of soybean varieties differed significantly in char land eco-system. BARI Soybean-6 produced the highest seed yield (2099 kg/ha) while Sohag was the lowest yielder (1002 kg/ha). Yield variation in different soybean varieties was attributed to the cumulative effects of different yield components. Similar finding was also reported by Islam and Biswas (2010). The results revealed that the performance of BARI Soybean-6 was the best in char land eco-system under climate change situation.

Table 5. Tuber yield and yield contributing characters of potato varieties at char land eco-systems under climate change situation (Kushtia, 2012-13).

Varieties	Plant/m^2 (no.)	Tuber/plant (no.)	Tuber wt /plant (g)	Single tuber wt. (no.)	Tuber yield (t/ha)	Yield increase over local (%)
BARI Alu-7 (Diamant)	6.66	9.6	522	54.4	27.82	33.9
BARI Alu-8 (Cardinal)	6.66	8.9	473	53.1	25.18	21.2
BARI Alu-31 (Sagita)	6.66	8.3	460	55.4	24.50	18.0
Local (Belgium)	6.66	6.4	390	60.9	20.77	-
LSD $_{(0.05)}$	NS	0.7	33	3.8	3.11	-
CV (%)	2.3	6.5	5.2	4.9	9.2	-

Experiment 4

Number of tubers/plant, tuber weight/plant, single tuber weight and tuber yield/ha of potato varieties differed significantly (Table 5). Tuber producing capacity of potato varieties was different. BARI developed potato varieties were superior to Belgium (farmers practicing variety) in respect of tubers/plant. The maximum number of tubers/plant (9.6) was recorded in BARI Alu-7 which was statistically identical with BARI Alu-8 (8.9). The minimum number of tubers/plant (6.4) was found from Belgium. Tuber weight/plant varied among potato varieties. The highest tuber weight/plant (522g) was found from BARI Alu-7. Tuber weight/plant of BARI Alu-8 (473g) and BARI Alu-31 (460 g) was at par while the lowest in Belgium (390 g).Tuber weight/plant directly contributed to the variation in yield of potato varieties rather than single tuber weight/plant. The largest sized tuber (60.9 g) was obtained from Belgium variety. On the contrary, tuber size of BARI potato varieties was identical (53.1-55.4 g) and significantly lower than Belgium variety. Tuber yield of potato varieties varied significantly and the highest tuber yield (27.82 t/ha) was obtained from BARI Alu-7 which was at par with BARI Alu-8 (25.18 t/ha). The higher tuber yield in the aforesaid variety was occurred due to tuber/plant and tuber weight/plant though single tuber weight was much lower than Belgium variety.

Similar finding was corroborated with Abdullah *et al.* (2009). Belgium potato variety produced the lowest tuber yield (20.77 t/ha) due to lower tuber/plant as well as tuber weight/plant. Tuber yield of BARI developed potato varieties showed 18.0-33.9% higher than Belgium variety. The results revealed that BARI Alu-7 exhibited the best performance in char land eco-systems under climate change situation. Alternately, BARI Alu-8 might be grown in char land areas.

Experiment 5

Yield and yield components of mustard varieties are presented in Table 6. Number of days required from sowing to harvesting (84-102 days) of mustard varieties differed significantly. The duration of BARI Sarisha-16 was the longest (102 days) which was at par with BARI Sarisha-11 (101 days) and BARI Sarisha-13 (101 days). On the contrary, duration of BARI Sarisha-14 (84 days) and BARI Sarisha-15 (88 days) was identical but 8-14 days shorter than BARI Sarisha-16. Plant population/m^2 of different mustard varieties was statistically similar (55-60 plants/m^2) due to same planting system. On the other hand, number of siliqua/plant was significantly different among the varieties (Table 6). The highest number of siliqua/plant was recorded in BARI Sarisha-11 (155) which was identical with BARI Sarisha-16 (146). Inversely, BARI Sarisha-13 (69) and BARI Sarisha-15 (60) produced statistically similar number of siliqua/plant but much lower than BARI Sarisha-16 (146). The lowest number of siliqua/plant was observed in BARI Sarisha-14 (44). Number of seeds/siliqua is a genetically controlled trait and it also differed significantly in different mustard varieties. BARI Sarisha-14 had the highest number of seeds/siliqua (31). BARI Sarisha-11 (12) and BARI Sarisha-16 (12) produced statistically identical number of seeds/siliqua. Thousand seed weight of mustard varieties also varied significantly. Seed size i.e. 1000-seed weight of BARI Sarisha-13 (3.0 g), BARI Sarisha-14 (3.1 g) and BARI Sarisha-15 (3.2 g) was identical. BARI Sarisha-11 produced the smaller sized seeds (2.8g) which was statistically similar with BARI Sarisha-16 (2.9 g).

Yield is directly proportional to the cumulative effect of yield components. The highest seed yield was recorded in BARI Sarisha-11 (1536 kg/ha) which was at par with BARI Sarisha-16 (1499 kg/ha). The higher seed yields in the aforesaid varieties were occurred due to higher number of siliqua/plant though much lower in seeds/siliqua and also seed size. Mian and Islam (2010) also reported higher seed yield due to higher siliqua/plant. On the contrary, as a short duration varieties, BARI Sarisha-14 (1205 kg/ha) and BARI Sarisha-15 (1267 kg/ha) produced significantly lower yield compared to long duration varieties (101-102 days). The results revealed that BARI Sarisha-11 and BARI Sarisha-16 (long duration varieties) could be grown in char land areas for higher yield but if other crops grown in kharif-I then short duration mustard variety BARI Sarisha-14 and BARI Sarisha-15 may be grown.

Table 6. Seed yield and yield contributing characters of mustard varieties at char land eco-system under climate change situation (Kushtia, 2012-13).

Varieties	Days to maturity	Plant /m^2 (no.)	Siliqua/ plant (no.)	Seeds/ siliqua (no.)	1000- seed wt. (g)	Seed yield (kg/ha)
BARI Sarisha-11	101	59	155	12	2.8	1536
BARI Sarisha-13	101	55	69	25	3.0	1423
BARI Sarisha-14	84	57	44	31	3.1	1205
BARI Sarisha-15	88	60	60	22	3.2	1267
BARI Sarisha-16	102	59	146	12	2.9	1499
LSD $_{(0.05)}$	9.0	NS	9.5	0.9	0.2	111
CV (%)	7.3	10.1	7.5	3.4	5.1	6.0

NS = Not significant

Conclusion

The results revealed that BARI Masur-6 of lentil; BARI Hybrid maize-9 of hybrid maize; BARI Soybean-6 of soybean; BARI Alu-7 of potato and BARI Sarisha-11 of mustard performed the best in Golapnagar charland under climate change situation in Bangladesh.

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