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Evaluation of No Tillage Potato under Different Fertilizer Packages in Three Low Lying Areas of Bangladesh (AEZ-12)

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Abstract: The field experiment was carried out to find a suitable and economic dose of fertilizer (combination of N, P_2O_5, K_2O and S) for potato cultivation in no tillage mulching situation. Three fertilizer packages with a control (without fertilizer) were tested. At all locations, the treatment F_4 (120, 100, 120 and 20kg ha^{-1} N, P_2O_5, K_2O and S respectively, out yielded the control as well as other fertilizer doses. The tuber yield pattern due to different fertilizer packages followed the same trend for all tested locations but overall performance of Shariatpur was better than Madaripur and Gopalgong. The gross return, gross margin and marginal rate of return were also found the highest in same treatment at all the three locations.

Key words: No tillage, saturated soils, fertilizer packages, potato production, tuber yield

Introduction

Potato (*Solanum tuberosum* L.) is one of the most important vegetable as well as the cheapest source of carbohydrate in Bangladesh. Almost every family of the country consumes it. At present, potato ranks the first in vegetables in terms of area and production and is regarded as the third largest food crops in Bangladesh. Potato is one of the three leading staple food crops of the world next to wheat and rice. Its total production is about 285 million tons and it is a staple food in more than forty countries of the world (Ahmed, 1991). It forms an ideal basis for any section of the population as it adequately provides the needed calories with carbohydrates, proteins, minerals and vitamin C in reasonable quantities. In Bangladesh, potato is generally grown in the high land with several tillage operations (ploughing, laddering and cross ploughing) under ridge system. An intensive tillage required more energy, resulting in an increased cost of production and decreased net return (Bhattacharjee and Kushwah, 1988). Potato can also be cultivated by flat system rather than ridge systems. Previous research results showed that it is also possible to grow potato in the low lying heavy soils without any tillage operations i.e., no ploughing, no laddering, and no cross ploughing is needed in the saturated soils (Anonymous, 1989). In this system which is sometimes followed in Bangladesh, too, the soil is covered with mulch of rice straw and/or water hyacinth. The advantage of this system of cultivation has been recognized by many scientists at home (Abedin, 1979; Abedin *et al*., 1987; Ali and Abedin, 1988). No (zero) tillage condition can reduce the turn around period and help timely plantation (Bevins, 1986). Mulching in potato cultivation helps to provide a favorable growing condition by controlling weeds, conserving soil moisture, and lowering soil temperature during the daytime. Devaux *et al*. (1986) mentioned that mulching had a positive effect on moisture availability and soil temperature for potato cultivation in Rwanda. On the other hand, Allamaras *et al*. (1977) opined that mulching can enhance the root growth of potato.

Proper nutrition is very much essential in potato production. Nitrogen, phosphorus and potassium perform vital tasks in the growth and development of the potato plants. Lack of nutrient results in delayed growth processes and reduced yield. As the minimum tillage techniques can reduce the cost of cultivation by land preparation, earthing up, and harvest, it is therefore, essential to find the most profitable and proper dose of fertilizer for successful production. Perceptive the above facts, the present study was carried out to investigate the response of chemical fertilizer on potato under no (zero) tillage condition and to identify the economic viability of additional uses of fertilizer under that situation.

Materials and Methods

On-Farm trial was carried out at the farmer's field of Shariatpur sadar upazila of Shariatpur district (L-1), Madaripur sadar upazila of Madaripur district (L-2) and Gopalgong sadar upazila of Gopalgong district (L-3) during the rabi (winter) season of 1996-97 (November 1996 to March 1997). The land type was low with clay loam soil texture. All the areas were under the low Ganges river floodplain soils of Agro-ecological zone (AEZ) 12.

Chemical properties of experimental plot's soil.

Properties	Shariatpur	Madaripur	Gopalgong
pH	6.8	6.8	5.8
Organic matter (%)	1.81	2.00	2.46
Total N (%)	0.15	0.19	0.18
Avail. P (ppm)	9.0	9.0	8.0
Exch. K (me/100g soil)	0.57	0.70	0.60
Sulphur (ppm)	49.0	33.0	85.0

The land usually remains fallow during the rabi season (October to March). In the early kharif (mid April to mid May) sprouted seeds of rice (aus and aman at the ratio of 2:1 respectively) are usually broadcasted and it continues up to the early rabi (October) to harvest aman rice. After that there is no crop in the field up to mid April. This single factor experiment (combination of different fertilizers) was laid out in randomized complete block design (RCBD) with three replications at each location. One farmer was considered as one replication (i.e., in each location three farmers field was considered for three replications). The fertilizer treatments were viz. F_1 = Control (without any fertilizer), F_2.= 80, 60, 80 and 10kg ha^{-1} N, P_2O_5, K_2O and S, F_3.= 100, 80, 100 and 15kg ha^{-1} N, P_2O_5, K_2O, S and F_4 = 120, 100, 120 and 20 kg ha^{-1} N, P_2O_5, K_2O and S respectively. The sources of N, P_2O_5, K_2O and S were urea, triple super phosphate (TSP), muriate of potash (MP) and gypsum respectively. All fertilizers were applied as basal i.e., the same day of potato tubers sowing. The size of a unit plot was 8 x 6m^2 (48m^2). On an average, 28mm diameter of grade "A" potato tuber (cv. Diamant) were planted following the distances of 60 and 40cm row to row and hill to hill respectively. The tubers were planted on November 11, 12 and 14, 1996 at Shariatpur, Madaripur and Gopalgong respectively. After sowing of tubers all plots have been covered by sun dried water hyacinth (collected previously from the same land) as mulch materials at a height (thickness) of 15cm to retain the soil moisture. All intercultural operations like placement of mulch materials for second time after one month was done equally to harvest better yield from all treatments.

Plant height, number of tubers $hill^{-1}$, weight of tubers $hill^{-1}$ were

collected from twenty randomly pre-selected hills of each unit plot. The marketable tuber yield was recorded from three randomly selected spots of (6m^2) in each unit plot. The plot yield was converted into hectare yield. The collected data was analyzed statistically for analysis of variance (ANOVA) under RCB design to test for significant differences among treatments. A suitable statistical package MSTAT-C (Model 7) was used for analyzing the data.

Results and Discussion

Plant height: The growth of potato under no or zero tillage condition due to the application of fertilizer packages as evident that plant height was significantly influenced at Shariatpur but other two locations (Madaripur and Gopalgong) had no significant differences (Table 1). The maximum plant height was obtained from F_4 at Shariatpur (75.3cm), Madaripur (52.7cm) and Gopalgong (57.3cm). At all tested locations, plant height gradually increased due to the gradual increment of fertilizer package. Increased plant height of Shariatpur was statistically significant only but plant height of Madaripur and Gopalgong failed to show any significant difference due to fertilizer packages. At all locations, control (without any fertilizer) produced the shortest plants (45.0, 38.8 and 34.2cm in Shariatpur, Madaripur and Gopalgong respectively). This result is an agreement with the findings of Upadayay and Grewal (1987) where they pointed out that higher fertilizers produced higher growth of potato.

Number of tubers per hill: The produced number of tubers hill^{-1} was significantly different for four treatments at Shariatpur but it was identical at other two locations (Madaripur and Gopalgong respectively). In case of Shariatpur, the maximum number of tubers was obtained from F_4 (6.4), which was followed by F_3 (5.4) and then F_2 (5.1). The minimum tuber number was recorded from F_1 (3.7) (Table 1). In case of Madaripur, the trend of Shariatpur was not followed although F_4 produced maximum number of tubers (6.7).On the other hand, F_2 produced the highest number of tubers (5.0) in Gopalgong. It has been observed that F_1 produced minimum number of tubers at all tested locations (3.7, 5.0 and 3.9 in Shariatpur, Madaripur and Gopalgong, respectively). This result indicates that fertilizers (especially on package basis) is one of the prime need for better tuberization of potato even it is practiced in the zero tillage mulching situation.

Tuber weight: The weight of tubers hill^{-1} was statistically significant at all tested locations (Table 2). In Shariatpur, the maximum tuber weight per hill was recorded for F_4 (438g hill^{-1}), which was statistically superior over other fertilizer treatments. The tuber weight per plant of F_3 (322g hill^{-1}) and F_2 (288g hill^{-1}) had no significant variation although F_3 gave more tuber weight. The minimum tuber weight per plant of potato was recorded from F_1 (183g hill^{-1}). In case of Madaripur, the maximum tuber weight per plant was recorded from F_4 (467g hill^{-1}) but it was identical with F_3 (373g hill^{-1}) and F_2 (350g hill^{-1}) and the minimum tuber weight was obtained from F_1 (223g hill^{-1}). In case of Gopalgong, the maximum tuber weight per plant was recorded from F_4 (465g hill^{-1}). The treatment F_3 and F_2 were at par although F_3 gave 63g more tuber weight hill^{-1}. The minimum tuber weight was observed from F_1 (223g hill^{-1}).

Tuber yield: The yield of tuber was statistically significant at all tested locations (Table 2). In case of Shariatpur, the highest tuber yield was recorded from F_4 (22.61t ha^{-1}), which was statistically superior over other treatments. The tuber yield of F_3 (18.77t ha^{-1}) and F_2 (16.36t ha^{-1}) had no significant variation although F_3 gave 2.41t ha^{-1} more tuber yield than F_2. The minimum tuber yield was recorded for F_1 (10.62t ha^{-1}). In case of Madaripur, the maximum tuber yield was recorded from F_4 (16.54t ha^{-1}) and it was significantly different from other treatments. The treatment F_3 (12.53t ha^{-1}) and F_2 (11.77t ha^{-1}) were at par. The minimum tuber yield was obtained from F_1 (8.57t ha^{-1}). In case of Gopalgong, the maximum tuber yield was recorded from F_4 (18.57t ha^{-1}) and it was significantly different from other treatments. The treatment F_3 (14.70t ha^{-1}) and F_2 (13.10t ha^{-1}) were identical. The minimum tuber yield was recorded from F_1 (11.15t ha^{-1}). The tuber yield pattern due to different fertilizer packages effect followed the same pattern for all tested locations but overall performance of Shariatpur was better than Madaripur and Gopalgong. These results are in agreement with the findings of Upadayay and Grewal (1987) who concluded that fertilizer has a positive effect on tuber yield of potato cultivation. The use of water hyacinth mulch in potato cultivation has been in practice in some areas but it has also been proved that it requires fertilizer for successful production. Burrows and Larson (1962) and Willis *et al.* (1977) reported that mulch reduced soil temperature that was found to be beneficial for potato cultivation in the tropics.

Table 1: Plant height and tuber number of potato as influenced by different fertilizer doses under no tillage condition of greater Faridpur district

Treatment	Plant height (cm)				Tuber number (hill^{-1})			
	L-1	L-2	L-3	Mean	L-1	L-2	L-3	Mean
F_1	45.0b	38.8a	34.2a	39.34	3.7c	5.0a	3.9a	4.2
F_2	53.2b	48.9a	47.8a	51.22	5.1b	5.6a	5.0a	5.2
F_3	59.5ab	51.7a	50.7a	53.97	5.4b	5.4a	4.4a	5.1
F_4	75.3a	52.7a	57.3a	60.50	6.4a	6.7a	4.9a	6.0
CV (%)	15.3	16.8	11.3	---	8.5	17.2	19.8	--

Table 2: Tuber yield of potato as influenced by different fertilizer doses under no tillage condition of greater Faridpur district

Treatment	Tuber weight (g hill^{-1})				Tuber yield (t ha^{-1})			
	L-1	L-2	L-3	Mean	L-1	L-2	L-3	Mean
F_1	183c	283bc	223c	263	10.62c	8.57c	11.15c	10.11
F_2	288b	350ac	291bc	309	16.36b	11.77bc	13.10bc	13.74
F_3	322b	373ab	353b	350	18.77b	12.53b	14.70b	15.33
F_4	438a	467a	465a	457	22.61a	16.54a	18.57a	19.24
CV (%)	14.9	14.3	11.25	---	11.1	14.9	11.6	---

The means followed by the same letter do not differ significantly at LSD (P≥ 0.05), L-1= Shariatpur, L-2= Madaripur and L-3= Gopalgong, F_1= Control (without any fertilizer); F_2= 80, 60, 80 and 10Kg ha^{-1} N, P_2O_5, K_2O and S; F_3= 100, 80,100 and 15Kg ha^{-1} N, P_2O_5 , K_2O, and S; F_4= 120,100,120 and 20Kg N, P_2O_5 , K_2O, ha^{-1}

Table 3: Partial budget analysis for MRR(%) of potato as influenced by different fertilizer dose under no tillage condition of greater Faridpur district

Treatment	Gross return (Tk.ha^{-1})	Fertilizer cost (Tk.ha^{-1})	Gross margin (Tk.ha^{-1})	Marginal gross margin (Tk.ha^{-1})	Additional cost for fertilizer (Tk.ha^{-1})	MRR (%)
Shariatpur						
F_1	42480	--	42480			
				19369	3591	539
F_2	65440	3591	61849			
				8509	1131	752
F_3	75080	4722	70358			
				14229	1131	1258
F_4	90440	5853	84587			
Madaripur						
F_1	34280	--	34280			
				9209	3591	256
F_2	47080	3591	43489			
				1909	1131	168
F_3	50120	4722	45398			
				14909	1131	1318
F_4	66160	5853	60307	--	--	--
Gopalgong						
F_1	44600	--	44600			
				4209	3591	117
F_2	52400	3591	48809			
				5269	1131	466
F_3	58800	4722	54078			
				14349	1131	1268
F_4	74280	5853	68427			

Tk.= Taka (the official currency of Bangladesh) 1 US $= TK..40.00 (during potato harvest time i.e., February 1997)

Cost of fertilizer (Tk. kg^{-1})			Price of products (Tk. kg^{-1})
N	=	15.55	Potato = (as per local price of Madaripur during February, 1997)
P_2O_5	=	1.67	
K_2O	=	11.00	
S	=	16.67	

Economic performance: Partial budget analyses of potato yield (Table 3) due to different packages of fertilizer reveals that F_4 gave the maximum marginal rate of return (1258, 1318 and 1268% in Shariatpur, Madaripur and Gopalgong, respectively). The highest MRR (1318%) was calculated from F_4 at Madaripur. The MRR from F_4 of Shariatpur (1258%) and Gopalgong (1268%) were more or similar with the same fertilizer treatment (F_4). The higher MRR in F_4 indicates that if a farmer is able to spend additional one hundred Taka for fertilizer, then he could get an additional return of Tk.1258, 1318 and 1268% ha^{-1} at Shariatpur, Madaripur and Gopalgong respectively from its additional yield.

The observed results and foregoing discussion indicate that the gradual increasing doses of fertilizer gave gradual yield increment of potato and the highest dose (F_4) every where out yielded over control but to some extent higher yield over other doses of fertilizers. Potato production in the low lying heavy soil is feasible without any tillage operation which involves a lot of investment in the initial stage of cultivation. The highest doses of fertilizer gave the best result, which indicates that the application of balanced doses of fertilizer is very much important although it is grown in the heavy and saturated soil condition in the low lying areas. This investigation should again be verified with further increased doses of fertilizer packages because the yield has an increasing trend towards the increased fertilizer doses.

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