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Effect of integrated use of manure and fertilizer on the growth and yield of potato

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Abstract

An experiment was set up in the Research Farm of Patuakhali Science and Technology University, during the rabi season of 2015 to evaluate the effect of fertilizers and manures on the growth and yield of Potato. The experiment was laid out in a Randomized Complete Block Design (RCBD) with two potato varieties namely Diamant (V_1) and Cardinal (V_2) and five different types and rates of organic manures and inorganic fertilizers *viz.* T_0: Control , T_1: NPK, T_2: NPK + CW(Cowdung), T_3: NPK+ PM(Poultry Mannure) and T_4: CW(Cowdung), + PM(Poultry Mannure) were used for the present study. The two–factor experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Result showed that almost all the characters were affected significantly due to the effect of varieties, organic–inorganic fertilizer and their combinations .In case of treatments, NPK with PM also showed the tallest plant (39.76 cm), highest fresh and dry weight (95.97 and 6.05 g plant^{-1}, respectively), CGR and RGR (0.086 and 0.218 g m^{-2} day^{-1}, respectively), gross (24.36 t ha^{-1}) and marketable (23.39 t ha^{-1}) compared other treatments. In case of interaction, the highest plant height (41.00 cm), highst fresh and dry weight (96.87 and 3.62 g plant^{-1}, respectively), highest CGR and RGR (0.089 and 0.228 g m^{-2} day^{-1}, respectively) as well as the highest gross (24.45 t ha^{-1}) and marketable (23.67 t ha^{-1}) yield were recorded in Diamant at NPK with PM. From the above observation it may be concluded that the variety Diamant at NPK + PM was more effective under Patuakhali region.

Key words: Mannure, fertilizer, growth and yield of potato

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Introduction

the world belongs to the family Solanaceae (known as the nightshades). It is also known as 'The king of vegetables', has emerged as fourth most important food crop (Ghosh and De, 2011). Today it is the 4th most important food crop in the world, with annual production approaching 300 million tons (CIP, 2007).

The main reasons for low yield is the use of low yield potential varieties, use of poor quality seed tuber and inefficient management practices.Fertilizer application is one of the best means of increasing yield per unit area. Such the above facts of included findings, the present research were determine the performance study of two potato verities as influence by the different rates of organic or inorganic or organic–inorganic fertilizer in respect of morphological, yield and yield components under Patuakhali region. With these facts in mind, the present study was undertaken to find out the most productive variety, to select the effective combination(s) of organic or inorganic and organic–inorganic fertilizer that will ensure the higher production of potato; and finally to identify the best combination(s) of variety and organic–inorganic fertilizer in respect of production potentiality.

Materials and Methods

The research work was conducted at the research farm of Patuakhali Science and Technology University (PSTU), Dumki, Patuakhali during the period from November, 2015 to February, 2016. The two cultivars of Potato namely Diamant (V_1) and Cardinal (V_2) were used as planting materials for the present study. The treatments of the present study are as follows: T_0: Control; T_1: NPK; T_2: NPK + CD (Cowdung); T_3: NPK+ PM (Poultry Mannure) and T_4: CD (Cowdung) + PM (Poultry Mannure).Two varieties of potato were used as the level factor A and the experiment were compared with five different treatment combinations of organic–inorganic fertilizers including a control as the level factor B.

Results and Discussion

Effects of interaction of varieties and organic–inorganic fertilizer

A significant variation for plant height at different DAP was also found due to the effect of interaction between varieties and inorganic fertilizers or organic manures. At 30 DAP, the treatment combination of V_1T_3 (Diamant × NPK + PM) produced the highest plant height which was statistically close to V_1T_1 (Diamant × NPK), V_1T_2 (NPK + CW) and V_2T_3 (Cardinal × NPK + PM) (9.410, 9.267 and 8.623 cm, respectively at 30 DAP. The result of 45 DAP and 60 DAP were in same line with the ranges of 16.01 (V_2T_0) to 20.34 cm (V_1T_3) at 45 DAP and 19.23 (V_2T_0) to 25.13 cm (V_1T_3) at 60 DAP.

Table 1. Effects of interaction of varieties and organic–inorganic fertilizer on plant height at different days after planting (DAP)

Varieties	Treatments	Plant height (cm) at different DAP			
		30	45	60	75
Diamant	T_0	7.480^{cde}	17.337^{f}	20.67^{de}	32.20^{ef}
	T_1	9.410^{ab}	19.367^{b}	22.67^{b}	35.59^{cd}
	T_2	9.267^{ab}	19.087^{c}	21.80^{c}	33.81^{de}
	T_3	9.790^{a}	20.34^{a}	25.13^{a}	41.00^{a}
	T_4	7.523^{cde}	17.867^{e}	21.67^{c}	36.12^{c}
Cardinal	T_0	6.367^{e}	16.013^{h}	19.23^{f}	31.10^{f}
	T_1	8.413^{bc}	18.367^{d}	21.43^{cd}	35.36^{cd}
	T_2	6.700^{de}	16.443^{g}	20.53^{e}	34.34^{cd}
	T_3	8.623^{abc}	19.033^{c}	23.47^{b}	38.52^{b}
	T_4	7.753^{cd}	17.443^{f}	20.03^{ef}	32.29^{ef}
LSD(0.05)		**1.131**	**0.1799**	**0.8227**	**1.819**
CV (%)		**8.11**	**1.31**	**2.21**	**3.03**
Sig. level		*	**	*	**

In a column figures having similar and no letter(s) do not differ significantly at 5% level whereas figures with dissimilar letter(s) differ significantly as per DMRT at same level; DMRT= Duncan's Multiple Range Test; LSD= Least significant difference and CV= Coefficient of variation; **= Significant at 1% level of probability and *= Significant at 5% level of probability; **T_0:** Control ($N_0P_0K_0$), **T_1:** NPK, **T_2**: NPK + CW, **T_3**: NPK + PM and **T_4**: CW + PM

Effects of interaction of varieties and organic–inorganic fertilizer on number of leaves plant^{-1} at different days after planting (DAP)

Effects of interaction also showed significant variation for number of leaves plant^{-1} at different DAP (Table 2). The statistically same maximum number of leaves plant^{-1} (16.67 and 16.33) was found from the interaction treatments of V_2T_3 (Cardinal × NPK + PM) and V_2T_1 (Cardinal × NPK), respectively at 30 DAP while the variety Diamant grown under control condition (V_1T_0) recorded the minimum number of leaves plant^{-1} (9.00).

Table 2. Effects of interaction of varieties and organic–inorganic fertilizer on number of leaves plant^{-1} at different days after planting (DAP)

Varieties	Treatments	Numebr of leaves plant^{-1} at different DAP			
		30	45	60	75
Diamant(V1)	T_0	9.000^{g}	11.67^{f}	19.67^{g}	26.33^{g}
	T_1	12.67^{de}	14.00^{d}	27.00^{cd}	42.00^{b}
	T_2	12.00^{e}	12.67^{e}	24.67^{e}	34.00^{e}
	T_3	14.00^{b}	16.33^{c}	28.33^{bc}	43.00^{ab}
	T_4	10.33^{f}	12.00^{ef}	22.00^{f}	30.00^{f}
Cardinal(V2)	T_0	13.00^{cd}	16.00^{c}	24.33^{e}	33.67^{e}
	T_1	16.33^{a}	17.33^{ab}	29.00^{b}	41.33^{bc}
	T_2	14.00^{b}	16.67^{bc}	27.67^{bcd}	39.00^{cd}
	T_3	16.67^{a}	17.67^{a}	33.00^{a}	45.00^{a}
	T_4	13.67^{bc}	16.33^{c}	26.33^{d}	37.33^{d}
LSD(0.05)		**0.7298**	**0.8473**	**1.292**	**2.413**
CV (%)		**3.24**	**3.28**	**2.87**	**3.78**
Sig. level		**	**	*	**

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Table 3. Effects of interaction of varieties and organic–inorganic fertilizer on number of branches plant^{-1} at different days after planting (DAP)

Varieties	Treatments	Numebr of branches plant^{-1} at different DAP			
		30	45	60	75
Diamant(V1)	T_0	5.220 g	5.990 e	6.667	7.333 ef
	T_1	6.110 c	6.553 c	8.333	8.667 cd
	T_2	5.667 e	6.110 de	8.000	8.000 de
	T_3	7.000 a	7.343 a	8.000	10.33 a
	T_4	5.443 f	6.223 d	8.000	8.667 cd
Cardinal(V2)	T_0	5.000 i	5.443 g	6.333	7.000 f
	T_1	5.767 d	6.110 de	7.333	7.000 f
	T_2	5.443 f	5.780 f	7.667	9.000 bc
	T_3	6.443 b	6.777 b	8.333	9.667 ab
	T_4	5.110 h	5.663 f	6.533	7.667 ef
LSD(0.05)		**0.05425**	**0.1213**	**0.9364**	**0.8028**
CV (%)		**0.64**	**1.12**	**7.26**	**5.61**
Sig. level		**	**	ns	**

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Effects of interaction of varieties and organic–inorganic fertilizer on number of branches plant^{-1} at different days after planting (DAP)

Effects of interaction showed significant variation for the number of branches plant^{-1} at different DAP except 60 DAP where branch number varied from 6.33 (V_2T_0) to 8.33 (both V_1T_1 and V_2T_3) but they

were statistically identical. At 75 DAP, the highest number of branches plant^{-1} (10.33) was obtained from the treatment V_1T_3 (Diamant × NPK + PM) followed (9.67) by V_2T_3 (Cardinal × NPK + PM) while Cardinal showed lowest number of branches plant^{-1} (7.00) under untreated control treatment (V_2T_0).

Effects of interaction of varieties and organic–inorganic fertilizer on leaf area

There was a significant variation for leaf area due to the effects of interaction of varieties and organic–inorganic fertilizers and manures. At 30 DAP, the variety Cardinal grown under NPK + PM (V_2T_3) condition observed the highest leaf area (36.84 cm^2) closely followed (35.13) by the variety Diamant under same condition (V_1T_3) while Diamant grown under control condition (V_1T_0) obtained the lowest leaf area (23.72 cm^2).

Table 4. Effects of interaction of varieties and organic–inorganic fertilizer on leaf area at different days after planting (DAP)

Varieties	Treatments	Leaf area (cm^2) at different DAP			
		30	45	60	75
Diamant	T_0	23.72 f	184.90 f	201.60 g	236.1 f
	T_1	32.10 cd	216.00 d	241.10 de	280.4 cd
	T_2	32.52 c	202.10 e	227.00 ef	258.1 e
	T_3	35.13 ab	235.00 bc	260.20 bc	296.0 c
	T_4	27.94 e	193.90 ef	218.90 f	262.1 de
Cardinal	T_0	30.07 d	143.60 h	169.60 h	212.4 g
	T_1	34.11 bc	244.60 b	269.80 b	360.2 b
	T_2	32.45 c	222.70 cd	247.60 cd	255.3 ef
	T_3	36.84 a	274.20 a	299.10 a	453.7 a
	T_4	33.54 bc	159.20 g	184.20 h	241.6 ef
LSD(0.05)		**2.063**	**13.42**	**15.59**	**20.16**
CV (%)		**3.78**	**3.77**	**3.92**	**4.12**
Sig. level		**	**	**	**

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Effects of interaction of varieties and organic–inorganic fertilizers

Leaf areas varied significantly from 1.78 to 2.76 cm2 at 30 DAP, 10.77 to 20.57 cm^2 at 45 DAP, 12.72 to 22.44 cm^2 at 60 DAP and 15.93 to 33.70 cm^2 at 75 DAP. From the above variation results of leaf area, it was found that the variety Cardinal grown under NPK + PM (V_2T_3) showed the highest result and same variety grown under control condition (V_2T_0) recorded the lowest result at all the data recording stages except 30 DAP.

Effect of inorganic fertilizers and organic manures on Total Dry Matter

Effect of inorganic fertilizers and organic manures had also statistically significant on total dry matter of potato at DAP.Among the treatments, the highest dry matter weight of potato (6.05 g plant^{-1}) was recorded in NPK + PM (T_3) followed by NPK (5.30 g plant^{-1}) at 75 DAP while control (T_0) obtained the lowest dry matter weight (3.90 g plant^{-1}).

Effects of interaction of varieties and organic–inorganic fertilizer

The total dry matter of potato at different DAP also varied significantly due to the effects of interaction where it increased significantly from 30 to 75 DAP.

Table 5. Effects of interaction of varieties and organic–inorganic fertilizer on leaf area index at different days after planting (DAP)

Varieties	Treatments	Leaf area (cm^2) at different DAP			
		30	45	60	75
Diamant	T_0	1.783 f	13.87 e	15.12 e	17.71 g
	T_1	2.407 cd	16.21 c	18.08 c	21.03 d
	T_2	2.440 bcd	15.16 d	17.03 d	19.36 ef
	T_3	2.633 ab	17.63 b	19.52 b	22.21 c
	T_4	2.100 e	14.55 de	16.42 d	19.66 e
Cardinal	T_0	2.257 de	10.77 g	12.72 g	15.93 h
	T_1	2.557 bc	18.35 b	20.24 b	27.02 b
	T_2	2.433 bcd	16.71 c	18.58 c	19.15 f
	T_3	2.763 a	20.57 a	22.44 a	33.70 a
	T_4	2.513 bc	11.94 f	13.82 f	18.13 g
LSD(0.05)		**0.1956**	**0.8645**	**0.8628**	**0.434**
CV (%)		**4.74**	**3.24**	**2.89**	**1.89**
Sig. level		**	**	**	**

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Table 6. Effects of interaction of varieties and organic–inorganic fertilizer on total dry matter of potato at different days after planting (DAP)

Varieties	Treatments	DW		
		30	45	60
Diamant	T_0	2.41 e	3.627 f	4.170 e
	T_1	3.18 b	4.480 b	5.397 b
	T_2	2.98 c	4.337 bc	4.917 cd
	T_3	3.36 a	5.147 a	6.197 a
	T_4	2.79 d	4.187 cd	4.813 d
Cardinal	T_0	2.04 f	3.250 g	3.623 f
	T_1	3.01 c	4.463 b	5.203 bc
	T_2	2.51 e	4.093 de	4.700 d
	T_3	3.19 b	4.950 a	5.903 a
	T_4	2.57 e	3.910 e	4.367 e
LSD(0.05)		**0.153**	**0.203**	**0.316**
CV (%)		**3.22**	**2.83**	**3.73**
Sig. level		*	*	*

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Effects of interaction of varieties and organic–inorganic fertilizer

CGR had also statistically significant due to the effects of interactions (Table 7). The variety Diamant showed the highest CGR (0.152 and 0.089 g m^{-2} day^{-1}) due to NPK + PM (V_1T_3) at the growth stages of 30–45 and 45–60 DAP, respectively while the variety Cardinal grown under same condition (V_2T_3) recorded the statistically same CGR (0.149 and 0.083 g m^{-2} day^{-1}, respectively).

Table 7. Effects of interaction of varieties and organic–inorganic fertilizer on CGR and RGR at different growth stages

Varieteis	Treatments	Crop growth rate (g m^{-2} day^{-1})		Relative growth rate (g m^{-2} day^{-1})	
		30–45	45–60	30–45	45–60
Diamant	T_0	0.1035 d	0.04580 cde	0.2648 f	0.1185 d
	T_1	0.1096 cd	0.07800 ab	0.2820 e	0.1920 b
	T_2	0.1150 cd	0.04880 cde	0.2940 de	0.1260 d
	T_3	0.1523 a	0.08930 a	0.3893 a	0.2280 a
	T_4	0.1185 bcd	0.05330 cd	0.3030 cd	0.1365 d
Cardinal	T_0	0.1025 d	0.03150 e	0.2625 f	0.0810 f
	T_1	0.1232 bc	0.06300 bc	0.3150 c	0.1620 c
	T_2	0.1348 ab	0.05180 cd	0.3450 b	0.1320 d
	T_3	0.1493 a	0.08277 a	0.3825 a	0.2070 b
	T_4	0.1142 cd	0.03900 de	0.2925 de	0.0990 e
LSD(0.05)		**0.01715**	**0.001715**	**0.001715**	**0.001715**
CV (%)		**2.05**	**4.05**	**0.79**	**1.86**
Sig. level		**	**	**	**

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Effects of interaction of varieties and organic–inorganic fertilizer on fresh weight of plant at different DAP

Effects of interaction also revealed significant difference for fresh weight of plant at 30, 45 and 60 DAP. The increment of the study period significantly influenced the fresh weight of plant due to all treatments. At 30 DAP, the highest weight of fresh plant (20.84g $plant^{-1}$) was recorded in treatment combination of V_1T_3 (Diamant × NPK + PM) and it was statistically close to V_1T_1 (Diamant × NPK), V_2T_3 (Cardinal × NPK + PM) and V_2T_1 (Cardinal × NPK) (20.52, 19.95 and 19.74 g $plant^{-1}$, respectively) while it was the lowest (14.29 g $plant^{-1}$) in V_2T_0 (Cardinal × control).

Effect of inorganic fertilizers and organic manures on Gross yield of potato

Gross yield of potato was significantly influenced by the effect of organic and inorganic based fertilizer. Among the fertilizer and manures treatments, NPK along with PM (T_3) produced the highest gross yield of potato (22.62 kg $plot^{-1}$ or 24.36 t ha^{-1}) followed by 100 NPK (T_1) (22.35 kg $plot^{-1}$ or 23.92 t ha^{-1}) while control treatment (T_0) obtained the lowest yield (21.12 kg $plot^{-1}$ or 21.86 t ha^{-1}). The application of NPK along with PM showed the highest gross yield

might be due to the application of PM was more effective than cow dung in presence of NPK in this study.

Table 8. Effects of interaction of varieties and organic–inorganic fertilizer on fresh weight of plant at different DAP

Varieties	Treatments	Fresh weight of plant (g plant^{-1}) at different DAP		
		30	45	60
Diamant	T_0	17.66 d	49.45 de	73.28 e
	T_1	20.52 ab	59.70 ab	95.04 b
	T_2	19.09 c	57.13 bc	94.68 b
	T_3	20.84 a	62.52 a	96.87 a
	T_4	17.92 d	53.49 cd	81.05 d
Cardinal	T_0	14.29 e	42.19 f	65.82 f
	T_1	19.74 abc	53.65 cd	91.92 c
	T_2	19.58 bc	46.94 ef	80.55 d
	T_3	19.95 abc	60.12 ab	95.07 b
	T_4	17.35 d	44.12 f	73.41 e
LSD(0.05)		**1.034**	**4.546**	**1.62**
CV (%)		**3.22**	**5.01**	**1.11**
Level of sig.		**	*	**

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Table 9. Effects of organic–inorganic fertilizers on gross and marketable yield of potato

Treatments	Gross yield (kg plot^{-1})	Gross yield (t ha^{-1})	Marketable yield (kg plot^{-1})	Marketable yield (t ha^{-1})
T_0	21.117 e	21.86	20.833 e	21.39
T_1	22.350 b	23.92	21.733 b	22.89
T_2	22.050 c	23.42	21.517 c	22.53
T_3	22.617 a	24.36	22.033 a	23.39
T_4	21.767 d	22.95	21.333 d	22.22
LSD(0.05)	**0.1151**	**–**	**0.03876**	**–**
CV (%)	**4.67**	**–**	**0.56**	**–**
Level of sig.	**	–	**	–

In a column figures having similar and no letter(s) do not differ significantly at 5% level whereas figures with dissimilar letter(s) differ significantly as per DMRT at same level; DMRT= Duncan's Multiple Range Test; LSD= Least significant difference and CV= Coefficient of variation and **= Significant at 1% level of probability

Effects of interaction of varieties and organic–inorganic fertilizer on Marketable yield of potato

Marketable yield significantly varied from 20.57 kg plot^{-1} or 20.95 t ha^{-1} to 22.20 kg plot^{-1} or 23.67 t ha^{-1} were highest and lowest result were obtained from the interaction treatments of V_1T_3 (Diamant × 100 NPK + PM) and V_2T_0 (Cardinal × control) respectively.

Table 10. Effects of interaction of varieties and organic–inorganic fertilizer on gross and marketable yield of potato

Varieties	Treatments	Gross yield (kg plot^{-1})	Gross yield (t ha^{-1})	Marketable yield (kg plot^{-1})	Marketable yield (t ha^{-1})
Diamant	T_0	21.400 f	22.33	21.100 g	21.83
	T_1	22.467 b	24.11	21.733 c	22.89
	T_2	22.000 d	23.33	21.500 d	22.50
	T_3	22.667 a	24.45	22.200 a	23.67
	T_4	21.833 e	23.06	21.400 e	22.33
Cardinal	T_0	20.833 g	21.39	20.567 h	20.95
	T_1	22.233 c	23.72	21.733 c	22.89
	T_2	22.100 cd	23.50	21.533 d	22.56
	T_3	22.567 ab	24.28	21.867 b	23.11
	T_4	21.700 e	22.83	21.267 f	22.11
LSD(0.05)		**0.1627**	**–**	**0.05425**	**–**
CV (%)		**4.67**	**–**	**0.56**	**–**
Level of sig.		**	–	**	–

In a column figures having similar and no letter(s) do not differ significantly at 5% level whereas figures with dissimilar letter(s) differ significantly as per DMRT at same level; DMRT= Duncan's Multiple Range Test; LSD= Least significant difference and CV= Coefficient of variation; **= Significant at 1% level of probability and *= Significant at 5% level of probability

Conclusion

Above observation of the present study, it may be concluded that the application of NPK with PM (T_3) was more effective combination for the production of potato while the variety Diamant was more suitable than Cardinal under Patuakhali region. The observation suggested that the production of potato can be more enhanced by applying NPK with PM. So, the application of NPK + PM may be recommended at farmers' level for profitable production of potato.

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