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Review Article

Effect of Fertilizer Doses and Mulching to Mitigate Soil Salinity and Maximize Yield of Transplanted Watermelon (Citrullus lanatus L.)

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Abstract

An experiment was conducted at Kuakata, Patuakhali in the rabi season of 2021-22 to verify the effect of different mulch materials for watermelon production under farmers field condition. The objectives were to test the possibility that salinity damage can be reduced by elevating K fertilization rate and to study the effects of mulch material and K fertilization interactions on watermelon yield and nutrient uptake under salt stress condition. Four different fertilizer doses T1= Soil Test Based (STB), T2= STB+ 50% K, T3=IPNS approach with 5ton/ha CD +50% K and T4-Farmers practices with many materials used P1= Silver color polythene mulch, P2= Straw mulch, P3= No mulch combination. Twenty days old poly bag seedling were used in farmers' field. Other nutrients were also applied following STB method. Fertilizer used as the rates of N117P30K30S25 (T1), N117P30K37S25 (T2), N92P22.5K45S25 with5t/ha cowdung (T3) and N100P40K35S30 (T4). All the plant growth, yield and quality characters were superior in IPNS approach with 5ton/ha CD +50% K with silver polythene (31.96 t/ha) while plants without mulch (control) and soil test based resulted (24.31ton/ha) poor growth and yield. The higher rates of K contributed to 7- 27% increased yield over only STB dose for Patuakhali which implies the necessity of higher dose of K in salt affected soil in augmenting yield. Thus, application of 25-50% higher rates of K over present STB dose under polythene mulch method of cultivation could be useful in minimizing salt stress and optimizing yield of watermelon in the study area. With economic point of view, IPNS with 5 ton/ha cowdung+50% K and silver polythene mulch seedling resulted the highest net return (375780 tk) and found more economical with highest cost:benefit (2.82) ratio.

Key Words: agribusiness; food crisis; agrarian transformation; agrifood systems

Introduction

In the southern region, huge land remains fallow in the rabi season after harvest of T. Aman rice. Among these, a significant part is medium highland, and the area would be about 50% of the total fallow land, where watermelon can be grown without competition or with a less competition with Rabi crops. The cultivable areas in coastal districts are affected with varying degrees of salinity. After T. Aman rice harvest land become dry crop establishment become very difficult. So, to find out a way to crop establishment polybag seedling transplantation an alternative. In this way, a huge fallow land in the rabi season could bring under cultivation, so that socio-economic condition of the farmers would be changed.

Salinity is one of the most detrimental factors limiting the productivity of agricultural crops, with adverse effects on germination, plant vigor and crop yield (Munns & Tester, 2008). In Bangladesh, salinization is one of the major natural hazards hampering crop production. High salt content affects the physiology of plants at the cellular and whole-plant levels. Ionic imbalance occurs in cells due to excessive accumulation of Na+and Cl−ions that reduce uptake of K+, Ca2+, and Mg2+(Bayuelo-Jimenez et al., 2003). It is already reported that elevated amount of K (50% of recommended rate) in coastal region increase yield (Shill et al. 2016). In coastal region of Bangladesh salinity were higher in the month of March and April.

Watermelon is one of the most growing crop in southern coastal region. After T. Aman rice harvest, it is cultivated as a cash crop. Watermelon production during 2017-18 at Patuakhali district was 13350 ha (DAE, Patuakhali). Most of the times watermelon production seriously hampered by early rainfall in March and higher salinity. During 2015-16 rain destroyed most of the watermelon in coastal region. So, watermelon is a very risky crop. To produce watermelon, farmers usually sow the seeds directly in the field at in January after T. Aman rice harvest that greatly affected by rain or hailstorm during March. It is reported that this situation could be overcome by early planting of seedling which may help to early harvest, escape hail storming loss and to get higher market price.

2.Materials and methods

An experiment was conducted at Kuakata, Patuakhali in the rabi season of 2019-20 to verify the effect of different fertilizer doses with mulch materials for watermelon production under farmers field condition. Four different fertilizer doses T1 = Soil Test Based (STB), T2 = STB+ 25% K, T3 = IPNS approach with 5ton/ha CD +50% K and T4-Farmers practices with mulch materials used P1 = Silver color polythene mulch, P2 = Straw mulch, P3 = No mulch combination. The treatment combination was shown in Table 1. Twenty days old poly bag seedling were used in farmer's field. The experiment was laid out in RCB design with three compact replications having unit plot size 6 m x 5 m. Seeds were sown on 16 January 2020 and harvested started on 15 April 2020. Initial soil nutrient status of experimental site was shown in Table 2 and Figure 1. Standard cultural practices were done as and when necessary. Data were collected plot wise and analyzed statistically in open-source software R.

Location	Fertilizer (kg/ha)							Cowdung(t/ha)
	Treatments	N	P	K	S	Zn	B	
Kuakata	T1	117	30	30	25	1.12	0.24	-
	T2	117	30	37.5	25	1.12	0.24	-
	T3	117	30	45	25	1.02	0.20	5
	T4	100	40	35	30	0	0	-

Table 1: Treatment combinations for watermelon

Location	Nutrient status (Soil test based)								
	pH	EC (dS/m)	OM (%)	K (meq/100g soil)	TotalN (%)	P (µg/g soil)	S (µg/g soil)	Zn (µg/g soil)	B (µg/g soil)
Average	5.7	1.47	0.76	0.25	0.04	2.90	14.33	0.52	0.40
STATUS	Acidic	Low	Very low	Low	Very low	Medium	High	Low	Low

Table 2. Initial soil nutrient status of experimental plot during 2019-20

Figure 1: Taking moisture data from experimental plot.

3.Result and Discussion

3.1Soil temperature

Soil temperature play important role to plant growth and seedling estabilishments. In the Polythene, Straw, and without mulch Soil and air temperatures were recorded at ten altenative day during transplanting to harvesting dated. Over the sampling dates soil temperature in polythene mulch treatment ranged from 22.3 to 38.5 °C. In the case of straw mulch from 21.4 to 34.2 °C but without mulch soil temperature soil temperature range varies 21.4-31.1 (Table 3). It indicated that under mulch treatment soil temperature fluctuated more compared to without mulch treatment. The mean temperature of soil in polythene mulch, straw mulch and no mulch treatment was 30.97, 28.1 and 26.15 °C, respectively. Thus, the results clearly evidenced that use of silver polythene mulch can increase soil temperature by 4.82°C. The air temperature was found 1 to 2 °C lower than the soil temperature during the entire data recording periods with mean of 24.5°C. Aragüés et al. (2014) reported that mulches accelerate crop development in cool climates by increasing soil temperature.

	Soil Temperature (^{0}C)			Air Temperature (^{0}C)
Dates	With polythene mulch	withstw mulch	No Mulch	
16.01.2020	24.5	23.6	22.5	20.8
25.01.2020	22.3	21.4	21.4	19.3
05.02.2020	24.5	23.7	23.6	21.2
15.02.2020	28.5	25.9	24.2	22.4
25.02.2020	30.9	27.3	26.4	24.6
05.03.2020	33.5	28.6	26.9	25.7
15.03.2020	34.7	30.7	27.6	26.8
25.03.2020	35.9	32.5	28.3	27.7
05.04.2020	36.4	33.5	29.5	28.9
15.04.2020	38.5	34.2	31.1	30.7
Mean	30.97	28.1	26.15	24.8

Table 3: Periodic soil and air temperature

3.2Effect of elevated levels of Potassium with different fertilizer doses

The soil was clay and slightly acidic. However, the values of N, P and K were below the critical values of the nutrients in the soil of Patuakhali district, these relatively low level of major nutrients signify the need for augmentation to enhance the optimal performance of watermelon production. The variety Jaguar Jumbos plants per plot were affected by different rates of fertilizers. The excessive level of K application in salt affected soil mostly maximized the yield of watermelon. The fruit yield further increased with the increasing dose K where the highest yield (31.61t ha-1) was recorded with 50% excess K doses with IPNS with 5 ton/ha cowdung , which was statistically similar to 30 % excess doses of STB K but significantly higher over rest of the K doses (Table 4). The higher rates of K contributed to 7-27% increased yield from soil test-based doses. The highest plants per plot (17.44) were obtained from IPNS with 5 t/ha cowdung+ 50% K ie. T3 Treatments where 50% excess K doses were used. The resulted treatment fertilizer doses were N92P22.5K45S25 with5t/ha cow dung. From above observation higher dose of K accelerate significant variation for Vine length, number of fruits per plant, individual fruit weight. The highest vine length (275.11), number of fruits per plant (17.79) and individual fruits weight (6.28) obtained from this treatment (T3). As a result, the highest yield (31.61) obtained from these treatments. Excess rates of K application in salt affected soil increased the yield and yield contributing character of watermelon and reducing the Na: K ratio in plant tissue. The lowest yield (24.85) was observed in treatment T1 (N117P30K30S25).

3.3Effect of Mulching

The result showed that different types of mulching material significantly influenced the growth parameters of watermelon viz- Plants per plot, Vine length, Number of fruits per plan and Individual fruit weight over control. Among different mulching treatments, treatment (P1) silver polythene mulch resulted higher Plants per plot (17.25), Vine length (265.42), Number of fruits per pit (1.77) and Individual fruit weight (5.54) (Table 5). The increase in growth parameters was attributed to sufficient soil moisture near root zone, increasing soil temperature, minimize soil salinity (Fig.1) and minimized the evaporation loss due to mulching. The extended retention of moisture and availability of moisture also leading to higher uptake of nutrient for proper growth and development of plants, resulted higher growth of plant as compared to control. It was found that all the treatment of mulching material was significantly increased the fruit yield of watermelon. Among all mulching treatments, maximum fruit yield (27.98 t/ha) recorded in treatment (P1) silver mulch which was higher as compared to other mulch. The lowest yield (25.33t/ha) were observed in without mulch condition.

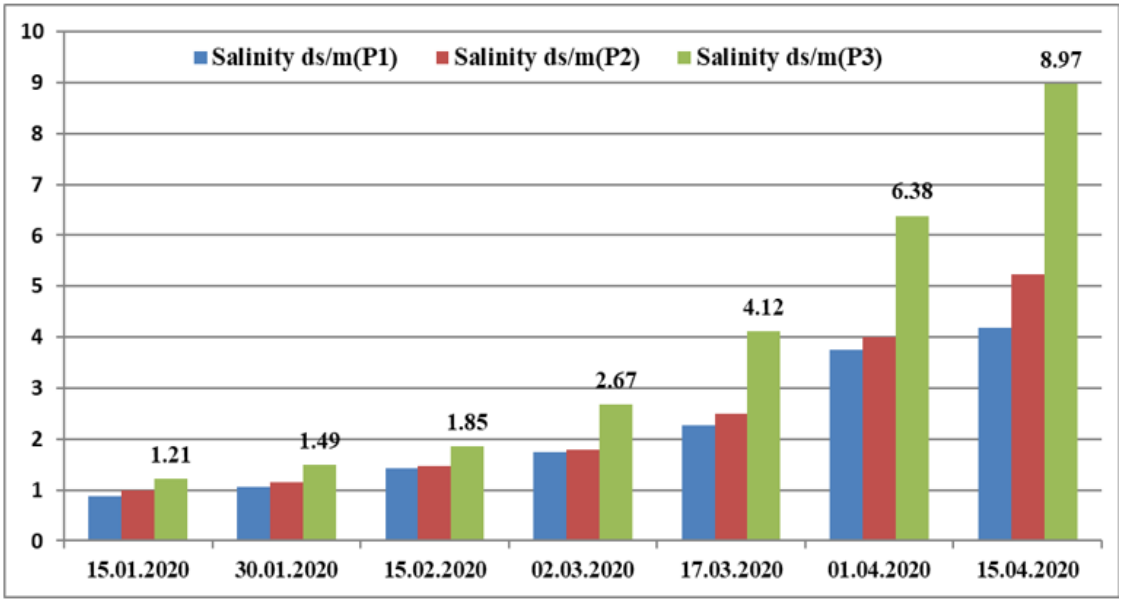

Fig 1: Salinity status of different mulch material at Kuakata, Patuakhali in 2019-20

Treatment		Plants/plot	Vine length (cm)	No. of fruits/pit	Fruit wt.(kg)	Fruit Yield (t/ha)	Yield increase (%)
Fertilizer doses	AppliedK (kg/ha)						
T1-STB	30	14.44 c	243.78 c	1.55 c	4.67 c	24.85 c	-
T2-STB+25% K	37.5	16.00 b	258.78 b	1.73 ab	5.22 b	27.56 b	10.91
T3	45	17.44 a	275.11 a	1.79 a	6.28 a	31.61 a	27.20
T4	40	15.67 b	252.44 bc	1.69 b	4.63 c	26.81 b	7.89
CV (%)	-	6.09	4.58	4.86	8.45	3.96	-
Lsd	-	0.94	11.53	0.08	0.43	1.06	-
Significant	-	***	***	***	***	***	-

Table 4: Effect of fertilizer with elevated level of Potassium on watermelon yield and yield attributes at MLT site Kuakata during rabi, 2019-20 T1- STB, T2- STB + 25% K, T3- IPNS with 5ton/ha Cowdung + 50% K, T4-Farmers Practice

Treatment	Plants/plot	Vine length(cm)	No. of fruits/pit	Fruit wt.(kg)	Fruit Yield (t/ha)	Yield increase (%)
P1	17.25 a	265.42 a	1.77 a	5.54 a	27.98 a	10.46
P2	15.75 b	258.75 a	1.69 b	5.12 b	26.84 b	5.96
P3	14.66 c	248.42 b	1.61 c	4.94 b	25.33 c	-
CV (%)	6.09	4.58	4.86	8.45	3.94	
Lsd	0.82	9.98	0.06	0.37	0.93	
Significant	***	**	***	***	**	

Table 5: Effect of mulching on watermelon yield and yield attributes at Kuakata during rabi, 2019-20

Interaction (TxP)	Plants/plot	Vine length (cm)	No. of fruits/pit	Fruit wt.(kg)	Fruit Yield (t/ha)	Yield increase (%)
T1P1	15.67 de	254.00 cdef	1.63 defg	4.33 f	25.34 de	4.24
T2P1	18.00 ab	263.00 abc	1.76 abcd	5.14 c	27.76 b	14.19
T3P1	18.67 a	282.33 a	1.89 a	6.33 a	31.96 a	31.47
T4P1	16.67 bcd	262.33 bcd	1.79 abc	4.69 e	26.77 bc	10.12
T1P2	14.33 ef	242.67 def	1.53 fg	5.07 c	26.88 cd	10.57
T2P2	15.67 de	259.67 abc	1.74 bcde	5.55 b	28.09 b	15.52

P1-Silver polythene mulch, P2- Straw mulch, P3- No mulch

Interaction (TxP)	Plants/plot	Vine length (cm)	No. of fruits/pit	Fruit wt.(kg)	Fruit Yield (t/ha)	Yield increase (%)
T1P1	15.67 de	254.00 cdef	1.63 defg	4.33 f	25.34 de	4.24
T2P1	18.00 ab	263.00 abc	1.76 abcd	5.14 c	27.76 b	14.19
T3P1	18.67 a	282.33 a	1.89 a	6.33 a	31.96 a	31.47
T4P1	16.67 bcd	262.33 bcd	1.79 abc	4.69 e	26.77 bc	10.12
T1P2	14.33 ef	242.67 def	1.53 fg	5.07 c	26.88 cd	10.57
T2P2	15.67 de	259.67 abc	1.74 bcde	5.55 b	28.09 b	15.52
	17.33 abc	275.67 ab	1.84 ab	6.53 a	31.26 a	28.59
	15.67 de	257.00 bcde	1.67 cdef	4.99 d	27.33 c	12.42
	13.33 f	234.67 f	1.50 g	4.61 e	24.31 f	-
	14.33 ef	263.67 cdef	1.67 cde	4.98 d	25.83 cdef	6.25
	15.33 cd	267.33 abc	1.65 def	4.98 d	26.62 bcd	9.50
	14.67 ef	238.00 ef	1.61 efg	4.19 f	25.35 def	4.28
	6.09	5.56	4.86	2.67	3.93	-
	1.64	19.97	0.14	0.235	1.85	-

Table 6: Interaction effect of K fertilizer and mulch on watermelon yield and yield attributes at Kuakata during rabi, 2019-20

Interaction (TxP)	Yield	Gross return (Tk./ha)	Total variable Cost (Tk./ha)	Gross margin(Tk./ha)	BCR
T1P1	26.77	481860	195000	286860	2.47
T2P1	27.76	499680	197000	302680	2.54
T3P1	31.96	575280	199500	375780	2.88
T4P1	25.34	474120	198000	276120	2.39
T1P2	27.33	491940	193000	298940	2.55
T2P2	28.09	505620	194500	311120	2.60
T3P2	31.26	562680	199500	363180	2.82
T4P2	26.88	483840	195000	288840	2.48
T1P3	24.31	437580	189000	248580	2.32
T2P3	25.83	464940	193000	271940	2.41
T3P3	26.62	479160	194000	285160	2.47
T4P3	25.35	459000	191500	267500	2.40

Note: Watermelon @ 18 Tk/kg

Table 7: Cost and return analysis of watermelon during rabi, 2019-20 at Kuakata, Patuakhali

3.4 Interaction effect of fertilizer and polythene mulch

The significance different observed Plants per plot, Vine length, Number of fruits per plan and Individual fruit weight and fruit yield due to interaction effect of fertilizer doses and mulches (Table 6). The highest plants per plot was observed in T3P1 (18.67) which was statistically identical T2P1 (18.00) and T3P2 (17.33). The lowest plants per plot (13.33) was observed in T3P4 treatments. The highest vine length was observed in T3P1 (282.33 cm) which was statistically identical T3P2 (275.67) and T2P1 (263.00). Number of fruits per pit was observed in T3P1 (1.89) which was statistically similar to T3P2 (1.84). The maximum fruit yield was observed in T3P1 (31.96) treatment because of all its yield boosting character were higher. Treatment combinations having IPNS with 5 t/ha cowdund+ 50% K and mulches (polythene or straw) might have conserved soil moisture for longer period and thus reduced soil salinity to some extent that favored better growth and yield. This finding is in agreement with Muromota et. al. (1991) and Mahmood et al. (2002).

Conclusion

Production of high value crops in the coastal saline areas particularly during Rabi season (dry season) is very limited due to rise in soil salinity. From this study it is revealed that, fertilizer doses and mulching both minimizes rise in soil salinity significantly. Besides, use of cowdung and extra amount of potassium

(K) with recommended fertilizers along with mulching helps to reduce soil salinity and increased crop yield.

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Competing interests

The authors declare no competing interests.

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