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Effect of Polythene Mulch on Growth and Yield of Sunflower (*Helianthus annuus*)

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Abstract

The study was undertaken to evaluate the effect of polythene mulch and different levels of irrigation water on growth and yield of sunflower in saline soil of Bangladesh. The sunflower variety Pacific Hysun-33 was the test crop. There were eight treatments consisting two continuous irrigation treatments in crop lines once at 25 DAS, and twice at 25 and 50 DAS and six rhizospheric irrigations at a rate of 125, 250 and 500 ml/plant without polythene mulch and with using polythene mulch. Polythene mulch increased plant percentage, plant height, leaf number/plant, leaf lamina length, leaf lamina breath, petiole length, stem diameter, head diameter, seed/head, root fresh weight, 200-seed weight, seed yield and straw yield by 130, 21, 16, 24, 35, 26, 30, 40, 72, 122, 12, 334 and 274%, respectively compared to no mulch (bare soil). The highest grain yield (2587 kg/ha) was obtained from T_8 treatment (rhizospheric irrigation 500 ml water/plant + polythene mulch) followed by T_6 (2428 kg/ha, rhizospheric irrigation 250 ml water/plant + polythene mulch) and T_4 (2190 kg/ha, rhizospheric irrigation 125 ml water/plant + polythene mulch) treatments. The present study observed that plastic sheet mulch produces more yield by conserving more moisture and having effective weed control. Thus, plastic mulch had better performance and could be used as good option for increasing sunflower yield.

Keywords

Sunflower, Yield, Saline soil, Polythene mulch, Bangladesh

Introduction

Bangladesh is a subtropical deltaic country of which north, east and west border surrounded by India and on the south-east by Myanmar and on the south by the Bay of Bengal. Most of the area covered by low-lying of the Ganges and Brahmaputra rivers [1,2]. Mean elevations range from less than 1 meter on tidal floodplains, 1 to 3 meters on the main river and estuarine floodplains, and up to 6 meters in the Sylhet basin in the north-east [3] that provide an easy passage to tidal saline water to the plain land of Bangladesh [4]. Due to geographic and low topographic setting the country is vulnerable to saline instruction and the impacts of future climate change [5]. However, soil and water salinity are the major constraints for higher crop productivity in the southern region of Bangladesh [6]. It is noted that salinity problem occupies near about 7% of total earth soils and it will cause 50% of land loss in the middle 21st middle century [7]; however, other potential affects concern not only crop yield but also salinization of lands, degradation of ground and surface water and the underground migration of salts from salt laden geological strata to rivers [8-10]. In agricultural plots, an excess of overland flow can enhance salinity and pollutant transport [11,12]. The average cropping intensity in the coastal area has not increased as much as compared to flood plain agriculture. About 30-50% of net cropped areas remain fallow in *Rabi* and *Kharif* seasons in the coastal region, mainly due to the salinity problem in soil and irrigation water, direct inundation by saline water, and upward or lateral movement of saline ground water during

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dry season (November-May), heavy soil consistency, poor soil fertility status, high osmotic pressure causing reduction in absorption of water and nutrients [13,14]. The prevailing salinity intrusion due to climate change has severely affecting the crop productivity in the saline regions of Bangladesh [14,15]. Therefore, introduction of new crops and/or crop varieties in the fallow lands of the coastal regions might be the scholastic technique for improvement of system productivity.

Sunflower is an important oil seed crop gaining paramount importance in the world and ranks next only to soybean and groundnut in the total world production of oil seeds [16,17]. As a salt-tolerant crop, sunflower is one of the most important economic crops in this region. Although sunflowers are classified as a salt-tolerant crop, they are also sensitive to salinity in the growth and development stages, especially during the emergence and early seedling stages. As a *Rabi* crop growing sunflower seriously hampered by soil and water salinity. Reducing root zone salinity is one beneficial strategy to improve sunflower emergence and stand establishment in saline fields. Irrigation with deep or shallow tube-well water is very costly and not commonly practiced in this area due to high underground water salinity [18]. Cannel and homestead ponds can be a potential irrigation water source but not sufficient to meet the seasonal demand. A judicious and efficient model for use of this water in irrigation purpose can improve the tolerance capacity of sunflower to soil salinity in *Rabi* season. A low water requirement and low cost irrigation system for cultivation of sunflower in saline soil is therefore required for optimum use of this limited water resources [16,19]. Capillary rise and evaporation loss of water from the soil might potentially be reduced by the use of polythene mulch [20-22]. Mulching, on the other hand, involves the use of organic or inorganic materials to cover the cropped soil surface. Mulching has the potential of reducing evaporation, conserve soil moisture, modify soil temperature, and improve aeration. However, there is a general lack of information with respect to the effects of irrigation, and mulching on growth and yield of sunflower in saline soil. This paper reports the effects of different irrigation

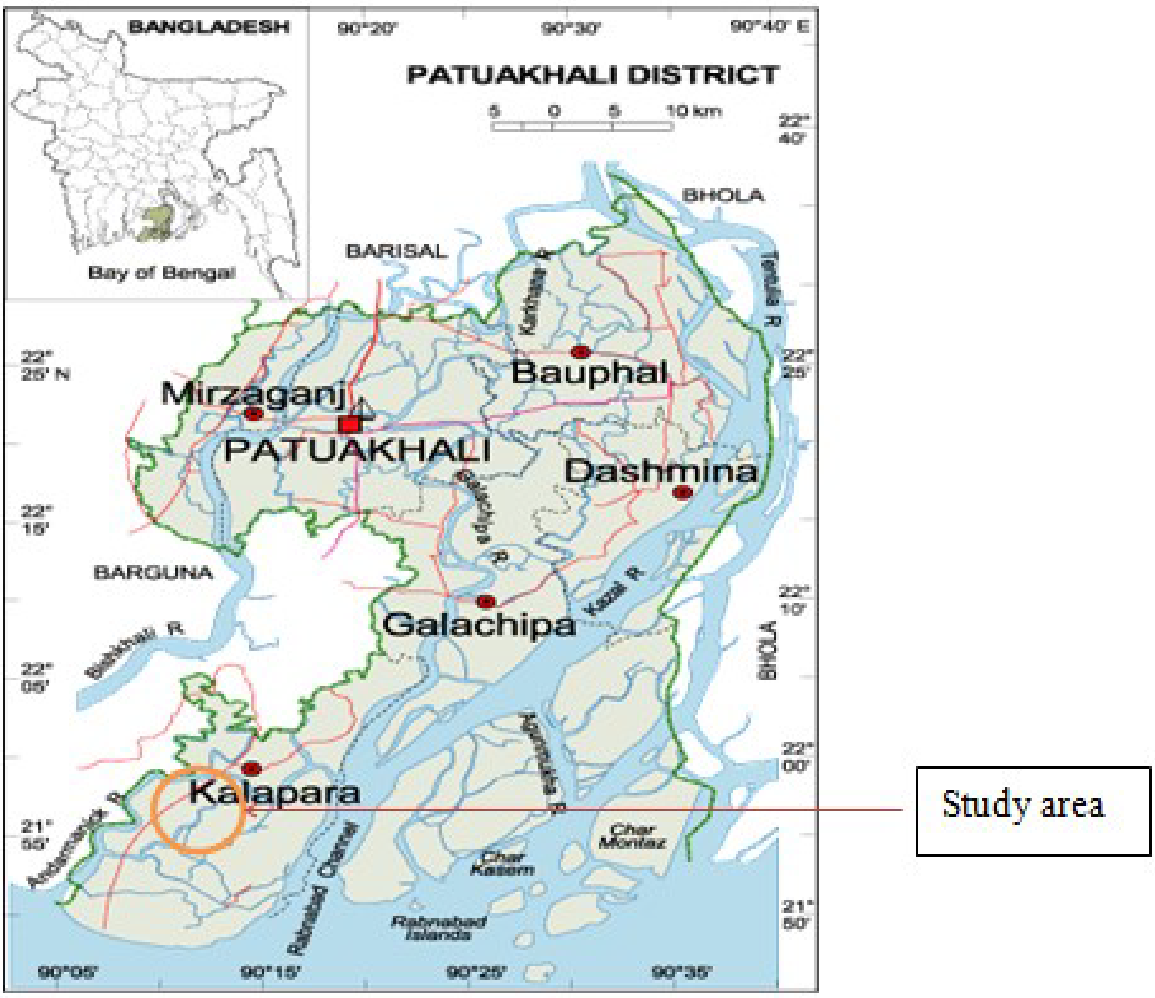

Figure 1: Study area of Patuakhali district of Bangladesh.

regimes on growth and yield of sunflower in relation to polythene mulching in saline soils, with the aim of devising efficient soil and water management practices for the *Rabi* season crop. We hypothesized that the dynamics of soil moisture and salinity, and their distribution in the soil profile as well as sunflower yield and yield components would be affected by polythene mulch.

Materials and Methods

Experimental area

The experiment was conducted at Tajepara village of Latachapali union under Kalaparaupzila of Patuakhali district, Bangladesh (Figure 1). Geographically, the experimental area is located at 21°59'10" N latitude and 90°14'32" E longitudes and the area is covered Gangetic tidal flood plains, AEZ-13 [23]. This region occupies a vast area of tidal floodplain land in the south part of Patuakhali district near Kuakata sea beach. Total coverage of this region is 17,066 km^2 with a total land volume of 17,06,600 ha [24] where the western coastal zone is surrounded by the Sundarbans (mangrove forest). The experimental area was situated in the subtropical climatic zone and characterized by heavy rainfall during the months of April-September (*Kharif* Season) and scanty rainfall during the rest period of the year [14]. The *Rabi* season (October-March) is characterized by comparatively low temperature and plenty of sunshine from November to February [25]. The physicochemical properties of the experimental soil are presented in (Table 1).

Treatments and crop management

The experiment was laid out in a randomized complete block design with three replications, each plot measuring 4 m × 3 m. The treatments were randomly distributed to the plots in each block. The plots were surrounded by 30 cm wide 10 cm high earthen bunds. Treatments included all combinations of eight irrigation regimes and polythene mulch. The treatments were as follows:

T_1 = Continuous irrigation in crop lines at 25 DAS, T_2 = Continuous irrigation in crop lines at 25 and 50 DAS, T_3 = Rhizospheric irrigation 125 ml water/plant, T_4 = Rhizospheric irrigation 125 ml water/plant + polythene mulch, T_5 = Rhizospheric irrigation 250 ml water/plant, T_6 = Rhizospheric irrigation 250 ml water/plant + polythene mulch, T_7 = Rhizospheric irrigation 500 ml water/plant and T_8 = Rhizospheric irrigation 500 ml water/plant + polythene mulch. Under the present study, the selected crop was sunflower and the variety was used as pacific Hysun 33 introduced by Bangladesh Rural Advancement Committee (BRAC). This is a popular high yielding sunflower variety in Bangladesh. This experiment was conducted in *Rabi* season 2014-2015. The soil was prepared with three plowing followed by laddering. For T_4, T_6 and T_8 field soil was covered with polythene sheet. A 5 cm diameter round cut hole on polythene sheet was made using a sharp end wooden stick maintaining plant to plant and row to row distance of 50 cm. Sunflower seeds were sown using this hole following dibbling method. For non polythene mulch treatments seeds were sown in rows maintaining same spacing. Irrigation was also made using this hole. As the treatments and layout five levels of irrigation was given in respective plot. In T_1 and T_2 treatment irrigation was given continuously along the crop rows using a bucket. For T_3-T_8 according to the treatments measured amount of water was given four times at 25, 35, 45 and 55 DAS in the root rhizospheric area using round cut hole of the polythene. During final land preparation, Rajdhan (5G) was applied to soil to control soil born insects. During growth period some insect attack was observed which was controlled by applying contact insecticide (Cutup). Every plot was received recommended rate of fertilizers as soil test basis using fertilizer recommendation guide [26]. The rate of N, P, K, S, B and Zn were 92, 32, 70, 20, 1.5 and 2 kg/ha, respectively, and the source of the nutrients were urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum, boric acid and zinc sulphate, respectively. In all the experimental plots TSP, MoP, gypsum, boron and zinc were applied during final land preparation. Urea was applied in three equal splits at final land preparation, 25 and 50 days after sowing. Regarding polythene mulch treatments urea was applied in the root rhizosphere zone using round cut hole of the polythene sheet (8.5G/SQ.M, Zhejiang, China) and picture of polythene sheet was shown in Figure 2.

Table 1: Chemical characteristics of soil in the experimental field.

Characteristics	Content	Interpretation
pH (soil:water = 1:2.5)	4.7	Strongly acidic
Electrical conductivity ($EC_{1:5}$) (dS/m)	1.4	Non saline
Organic matter (%)	0.63	Low
Total N (%)	0.09	Low
Available P (mg/kg)	13.1	Medium
Available S (mg/kg)	22.5	Medium
HCO_3^- (mg/100 gm Soil)	76.3	
Cl^- (mg/100 g soil)	127.8	

Growth parameters

Plant growth parameters were recorded at different stages; three plants were randomly chosen to measure plant height, leaf number, leaf lamina length, leaf lamina breath and stem diameter. Two rows from each plot were selected to measure the survival percentage. Root fresh weight, head diameter, seed per head and seed yield was also measured. After harvest, total above ground biomass was determined gravimetrically after oven drying, at 105 °C for 30 mininitially and then at 65-75 °C for 48

Figure 2: Preparation for hole on polythene sheet of the present study.

h [27]. Fresh seeds were oven-dried at 50 °C for 2 d and weighted to determine the average seed yield and 200-seed weights [28].

Collection, preparation and analysis of plant samples

The crop was harvested at fully ripening stage on 17 May 2015 then the plant samples (stover and seed) were collected and sun dried for three days. The plant samples were then oven dried at 65 °C and ground by a grinding machine to pass through a 20-mesh sieve. Stover and seed were stored in paper bags in a desiccator. The grain and straw samples were analyzed for determination of P concentrations a sub-sample weighing 0.5 g was transferred into a dry clean 100 ml long narrow tube. A 10 ml of di acid mixture (HNO_3: $HClO_4$ in the ratio of 3:1) was then added to it. After leaving for a while, the flask was heated at a temperature slowly raised to 180 °C. When the dense white fumes of $HClO_4$ occurred heating was momentarily stopped. The contents of the flask were boiled until they became clean and colorless. All the elements i.e. P was determined from this single digest following the method described by Yoshida, et al. [29].

Statistical analysis

Data were recorded on crop characters, soil analysis and plant analysis; were subjected to statistical analysis through computer based statistical program Mstat-C (Michigan State University, East Lansing, MI, USA) following the basic principles, as outlined by Gomez and Gomez [30]. All data were analyzed using the analysis of variance (ANOVA) procedure to test the effects of the treatments on the measured parameters. Mean comparisons were performed using the Fisher's LSD (the least significant difference) test at $P < 0.05$.

Result and Discussion

Salinity levels in soil

The variations in salt content within the growing periods of sunflower field soil among different treatments are shown in Figure 3. Among the treatments, the lowest salinity levels were observed in plots for T_4 (0.96-5.76 dS/m), T_6 (1.48-2.38 dS/m) and T_8 (1.60-3.02 dS/m) compared to others. This might be due to the application of rhizospheric irrigation with polythene mulch. For most of the treatments, the salt content increased rapidly up to harvest and similar trend was observed by Zhao, et al. [17]. Lower evaporative water loss contributed to the lower salt concentration in soil. In our experiments, the plastic mulch plots had much lower salt content in soil layer than the no-polythene mulch treatment plots (Figure 3).

Effect of polythene mulch on the growth parameters of sunflower

The effect of polythene mulch on sunflower yields and yield components is shown in Table 2. The highest sur-

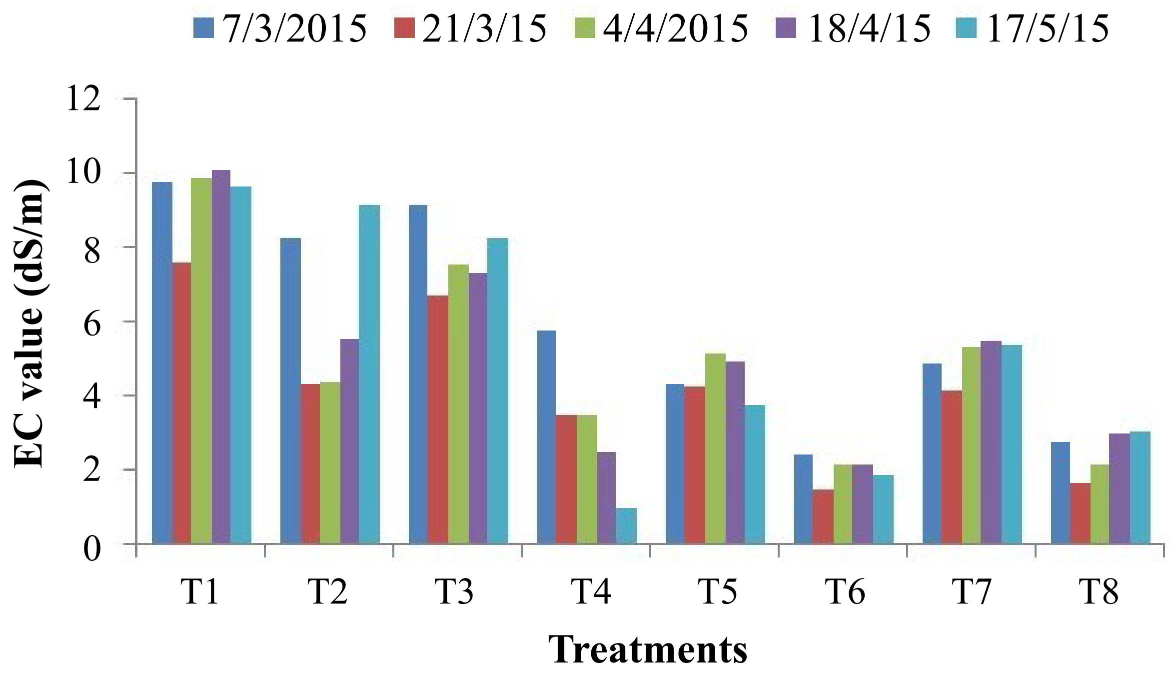

Figure 3: Spatial variation in salinity level around the crop cycle.

Table 2: Effects of polythene mulch and different irrigation water level treatments on different growth parameters of sunflower (*Helianthus annuus L.*).

Treatment	Survival percentage (%)	Plant height at 70 DAS (cm)	Plant height at harvest (cm)	Number of leaf at 70 DAS	Number of leaf at harvesting	Petiol length (cm)	Leaf lamina length (cm)	Leaf lamina breath (cm)	Stem diameter (cm) at harvest
T_1	33.3c	36.5cd	92.2b	18.8b	25.2bc	12.7c	17.5cd	15.4bc	1.8bc
T_2	36.7c	31.3d	92.8b	18.6b	25.5bc	12.9c	17.8cd	15.0c	1.7bc
T_3	40.0bc	32.8d	93.6b	19.5b	24.7bc	14.5bc	20.1bc	17.9b	2.0b
T_4	86.7a	89.4a	113.0a	25.9a	28.4ab	16.3ab	22.7ab	21.0a	2.3a
T_5	50.0b	40.1cd	88.7b	21.2b	26.1bc	12.1c	16.8d	13.7c	1.6c
T_6	86.7a	85.1a	113.5a	26.0a	30.1a	16.7ab	23.6a	21.2a	2.4a
T_7	30.0c	45.1c	94.4b	22.1b	24.0c	13.4c	19.9c	16.1bc	1.9b
T_8	90.0a	73.2b	107.3a	26.9a	28.4ab	17.4a	23.7a	21.3a	2.4a
CV	11.8	9.4	4.7	8.2	7.2	9.2	7.6	8.4	8.4
SE (±)	3.8	2.9	2.7	1.2	1.1	0.77	10.9	0.86	0.10

Note: Different letters in a column indicates statistically significant different at 5% level by DMRT.

vival percentage (90%) was obtained with treatment (T_8) which was statistically similar to the T_6 and T_4. The lowest survival percentage (30%) was obtained with treatment (T_7). Here the sole irrigation treatments T_1, T_2, T_3 and T_7 were observed with least and statistically similar survival percentage. At 70 DAS plant height ranged from 31.3 to 89.4 cm over the treatments. Treatment T_4 produced the tallest plant (89.4 cm) which was statistically similar to T_6 treatment. The shortest plant (31.3 cm) was observed in T_2. Polythene mulch treated plots produced higher plant height compared to the respective without polythene mulch treated plots. At harvest the plant height ranged from 88.7 to 113.5 cm over the treatments. Application of polythene mulch T_6 produced the tallest plants (113.5 cm), however it was statistically similar to all other polythene treated plots T_8 and T_4 (Table 2). Comparing 250 ml/plant rhizospheric irrigation, the use of polythene mulch treatment (T_6) increased over without polythene mulch treatment (T_5) all the growth parameters including plant height by 28%, number of leaves per plant by 15%, largest leaf length by 41%, largest leaf breath by 55%, length of petiole by 37%, stem diameter by 48%, root fresh weight by 179%, survival percentage by 73%, head diameter by 67%, irrigation water use efficiency by 334%, seed per head by 144%, seed yield by 334% and straw yield by 109%. Whereas the 200 seed weight was decreased by (5.2%).

The maximum number (26.9) of leaves per plant was recorded with T_8 treatment which was statistically similar to T_4 and T_6 treatments. At harvest the maximum number (30.1) of leaves per plant was recorded with T_6 treatment which was statistically similar to T_4 and T_8. All the polythene mulch treated plots produced higher number of leaves compared to the without polythene mulch treated plots. This result endorses that polythene mulch had positive influence on increasing number of leaves per plant. This was likely because of more water storage and lower salt content during the early growth period due to the polythene mulch layer [31], which benefited stand establishment and plant growth. Hussein, et al. [32] noticed a negative relationship between vegetative growth parameters and the increasing salt concentration in water of irrigation. The depression on stem, leaves and whole plants dry weight when irrigated with high salt concentration amounted by 57, 47 and 51% compared to the T_1 treatment. Ratnakara and Raib [33] observed that gradual decrease in root length, shoot length, fresh weight and dry weight of the seedlings occurred with increasing concentrations of NaCl in the growth medium.

The petiole length was ranged from 12.1 to 17.4 cm and the longest petiole was found in the plot appointed with the treatment T_8 and the second and third longest petiole was found in the treatment T_6 and T_4, respectively. It was varied from 16.8 cm in T_5 to 23.7 cm in T_8 treatment (Table 2). The highest result of T_8 treatment was further statistically similar with that of T_6 and T_4 treatments. The results clearly evidenced that polythene mulch had extraordinary performance compared to their respective non-mulch treatments. Significant variation was observed in leaf lamina breath due to projected treatment that was ranged from 13.7 to 21.3 cm. Largest leaf lamina breath (21.3) was recorded with treatment T_8 which was statistically similar to the treatment T_6 and T_4 (Table 2). Improved leaf area development could reduce evaporative loss, increased infiltration probably due to increased soil biological activities as a result of lower soil temperature were reported by Zamman and Choudhuri [34]. Enhanced radiant energy utilization under improved leaf area for dry matter and fruits yield increases was observed by Agele, et al. [35] for mulched tomato in Nigeria.

The largest stem diameter was found for the treatment T_8. Second and third largest diameter was found in the treatments T_6 and T_4, respectively. However the stem diameter found in treatment T_4, T_6 and T_8 was statistically similar which otherwise indicates for non-requirement of higher rate of irrigation in polythene mulch system. Regarding 500 ml/plant rhizospheric irrigation, the polythene mulch treatment (T_8) increased plant height, number of leaves per plant, largest leaf length, largest leaf breath, largest petiole length, survival percentage of sunflower by 14, 19, 19, 33, 29 and 200, respectively over without polythene mulch treatment (T_7). The results of three polythene mulch treatments clearly indicated that polythene mulch had outstanding performance even in high salinity of the test soil.

Effect of polythene mulch on the yield and yield contributing parameters of sunflower

The diameter of head ranged from 11.1 to 19.1 cm over the treatments. The largest head of sunflower (19.1 cm) was recorded in the plot treated with the polythene mulch (T_8) which was statistically similar with the treatments T_6 and T_4 (Table 3). The lowest size of head was observed in T_5, other treatments having no polythene mulch had the lower performance. All the plot of projected treatments involving polythene mulch had the better performance in respect of diameter of head of sunflower plant compared to non-mulch treatment. Agele, et al. [35] attributed this to favorable growth conditions notably sunshine hours and temperature.

The number of seed per head was ranged from 789 to 2188. The highest number of seed per head was found in T_8 and second largest number of seed per head was found in the treatment T_6 which was statistically similar to the T_4 (Table 3). The lowest number of seed per head was found for the T_5. Other treatments having without polythene mulch produced less number of seed per head

Table 3: Effect of polythene mulch on different yield contributing parameters and yield attribute of sunflower (*Hellinathus annus L.*).

Treatment	Head diameter (cm)	Seed per head	Weight of 200 seeds (g)	Seed yield (kg/ha)	Straw yield	Root fresh weight of (gm)	P content of seed (%)	P content of stover (%)
T_1	15.1bc	1251f	14.8b	446e	1.9cd	256d	0.17cd	0.04cde
T_2	13.0cd	1498d	12.9cd	416e	1.8d	159f	0.15e	0.05a
T_3	14.5c	1692c	11.7d	505de	2.7c	195e	0.15de	0.04cd
T_4	17.7ab	1922b	16.3a	2190c	7.5ab	355c	0.21b	0.04bc
T_5	11.1d	789g	14.4bc	559d	2.1cd	160f	0.23a	0.03def
T_6	18.6a	1924b	13.7bc	2428b	7.7ab	449a	0.13f	0.03f
T_7	14.6d	1378e	13.3bcd	596d	1.7d	204e	0.18c	0.05b
T_8	19.1a	2188a	13.6bc	2587a	8.3a	418b	0.12f	0.03ef
CV	10.5	3.8	6.6	4.9	10.3	3.6	2.5	8.1
SE (±)	0.94	35.1	0.52	34.9	0.15	5.8	0.002	0.002

Note: Different letters in a column indicates statistically significant different at 5% level by DMRT.

compared to the treatments having polythene mulch. From the above observation it was clear that the polythene mulch increased the seed number per head to a greater extent. As observed the highest 200-seeds weight was in T_4 treatment. The second highest 200-seed weight was observed in T_1. All of these polythene mulch treated plot produced the higher weight of 200-seed comparison with the relevant irrigation treatment without polythene mulch (Table 3). In T_1 treatment the weight of 200 seed was quite higher than T_6 and T_8 treatments which might be due to less survival rate, the plant received higher amount of resources like spacing and nutrients. The polythene mulch had a significant positive effect on the dry matter content of seed. Number of seeds per plant increased with decreasing percentage of medium and large seed and weight of 200 seeds. Improved vigour of root biomass development under grass mulch as a result of favorable soil condition could have resulted in the high yield of sunflower in saline soil. This suggested that sunflower partitioned more assimilate to seed development than to vegetative organs during the study period.

The highest grain yield (2587 kg/ha) was obtained from T_8 treatment. The second (2428 kg/ha) and third highest (2190 kg/ha) yield was recorded with the T_6 and T_4 treatments. All the polythene mulch treated plots (T_4, T_6 and T_8) produced higher yield compared to their respective without polythene mulch treatment (T_3, T_5 and T_7) and also to T_1 and T_2. This increase in yields could be attributed to the beneficial effects of mulching with plastic film on soil water and thermal status, which thus might have shortened the duration of growth stages [17]. Such difference in the seed yield may be attributed to favorable water regime in soil from the beneficial effect of polythene mulch for better mobilization of nutrients and also enhanced source capacity and sink strength which in turn influenced yield attributing characters favorably like head diameter, number of seeds per head and seed weight per head. These results are in accordance with the results of Tomar, et al. [16], an experiment was undertaken in Rajasthan, India, to determine the appropriate irrigation schedule for sunflower MSFH-8 in the *Rabi* seasons of 1995 to 1998.

There was a significant variation in straw yield with the ranged from 1.7 to 8.3 ton/ha. The highest straw yield was found in the T_8 treatment, and the second and third highest straw yield was found in the treatments T_6 and T_4, respectively (Table 3). The lowest straw yield (1.7 ton/ha) was found in the treatment T_5. The treatments receiving polythene mulch had the higher straw yield compared to their respective treatments having same amount of irrigation with no polythene mulch. When polythene mulch was used 250 and 500 ml/plant irrigation could not give any additional benefit over 125 ml/plant irrigation which otherwise indicates for no necessity of higher rate of irrigation in case of using polythene mulch. Regarding 500 ml/plant rhizospheric irrigation, the polythene mulch treatment (T_8) increased head diameter, seed per head, stem diameter, two hundred seeds weight, irrigation water use efficiency and seed and straw yield of sunflower by 31, 59, 24, 2.2, 333, 334 and 78%, respectively over without polythene mulch treatment (T_7). The results of three polythene mulch treatments clearly indicated that polythene mulch had outstanding performance even in high salinity of the test soil.

The root fresh weight ranged from 159 g in T_2 to 449 g in T_6 treatment (Table 3). The other treatments having polythene mulch i.e. T_8 and T_4 produced second and third highest fresh weight of root. On the other hand the treatments T_2, T_3 and T_5 had very closer root fresh weight. The P content of sunflower seed was found in a range of 0.12% to 0.23%. The highest P content of seed (0.23%) was measured in the treatment T_5 and the lowest was in the treatment T_6 which further was statistically similar to the treatment T_8 (Table 3). It appeared that the T_2 treatment resulted in the highest stover P content (0.05%) and the second highest stover P content (0.05%) was recorded at the plot of the treatment T_7. The lowest P content (0.03%) was noted in the treatment T_6 and the second lowest P content (0.03%) of was noted in T_8 but they are statistically similar. It was remarkable that the P content of seed and stover was comparatively lower in the treatment which includes polythene mulch in comparison with the without polythene mulch treatments.

It was hypothesized that application of mulch materials would enhance growth and seed yield of sunflower, this hypothesis was supported by our results. The benefits of plastic mulch in reducing water loss by evaporation, decreasing salt accumulation, conserving soil moisture, promoting crop growth and increasing crop water use efficiency have been widely reported [19,36-39]. Crop growth usually suffers pressures from both drought and salinity in saline soils. Therefore, to increase yield, it is not only important to manage the salt level but also to increase soil water storage.

Conclusions

Controlling slat accumulation in the root zone is critical to increasing crop yields in saline soils. Based on the field experiment conducted in the saline soils of Patuakhali District, southern part of Bangladesh, it can be concluded that the application of polythene mulch had significant effects on soil salinity dynamics and sunflower growth. Application of higher soil moisture (500 ml/plant) with polythene mulch and lower salinity in the root zone promoted sunflower growth. Use of polythene mulch provides a favorable condition for growing sunflower and increases growth parameters like plant height, leaf number, largest leaf length, breath of largest leaf, stem diameter, survival percentage, shoot dry weight, root fresh weight, head diameter, and the seed yield. Therefore, combining plastic mulching with irrigation water (500 ml/plant) can be an effective field management practice for growing sunflowers in saline soils of Bangladesh.

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