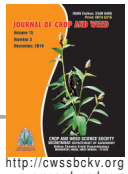
Journal of Crop and Weed, 18(1): 39-44 (2022)

ISSN- O : 2349 9400 ; P : 0974 6315



http://cwssbckv.org
www.cropandweed.com

Growth and profitability of cabbage under polyethylene mulch with spacing and N management in Terai region of West Bengal

***T. DAS AND J. C. JANA**

Department of Vegetable and Spice Crops, Uttar Banga Krishi Viswavidyalaya, Cooch Behar, West Bengal

Received : 02.01.2022 ; Revised : 19.01.2022 ; Accepted : 01.02.2022

DOI: https://doi.org/10.22271/09746315.2022.v18.i1.1530

ABSTRACT

The present study was conducted to investigate the effect of growth, yield and profitability of cabbage under polyethylene film mulch with different spacings and levels of nitrogen during winter season underTarai region of West Bengal, India, during winter season of 2017-2018 and 2018 -2019. Three levels of nitrogen: viz. 100,150 and 200 kg ha^{-1}and Three plant spacings viz. 45cm x 30 cm, 45 cm x 45 cm and 45 cm x 60 cm were applied in a Factorial Randomized Block Design with three replications. Nitrogen @200 kg ha^{-1} with the spacing of 45 cm x 30 cm was more effective which produced the highest marketable yield (79.46 t ha^{-1}) and lowest result was taken from N_1S_1.

Keywords: Cabbage, growth, nutrients, yield

Cabbage (*Brassica oleracea* L.var.*capitata*) one of the important temperate vegetable crops belongs to the *Brassicaceae* family. It prefers a cool and moist climate with an average temperature of 15^0 to 20^0 C and 60 to 90% relative humidity for growth and head formation. Among the different states of India, West Bengal is the largest producer of cabbage with an area of 79.4 thousand ha and production of 2288.50 thousand MT followed by Bihar, Orissa, Assam (NHB-2018).

The word mulch is derived from the German word "*molsch*" which means soft to decay as traditionally biological materials like dried leaves, straw, trash, *etc*.were used for mulching purposes. In agriculture, the use of mulch is highly beneficial for modification of soil temperature, controlling weed, soil conservation. After decomposition of organic mulch, it adds plant nutrients to the soil, improves soil structure, increases crop quality and yield. In addition, mulch can effectively minimize water vapour loss, soil erosion, and nutrient loss (Van Derwerken and Wilcox-Lee, 1988). However, in modern agriculture,various types of mulching materials are used.Overall it has been categorized as organic and inorganic mulches. Organic mulches include plants and animal materials such as leaf mold, compost, straw, hay, sawdust, peanut hulls, wood chips, shavings, and animal manures. As for inorganic mulch, it includes plastic materials such as polyvinyl chloride or polyethylene films. Polyethylene film is much preferred for the mulching of horticultural crops (Bhardwaj, 2011). The majority of plastic used today is based on LLDPE, a sit is more economic in use. Among various parameters spacing has been reported to affect the head weight and marketable yield percentage. Optimum plant population of cabbage is 20,000-70,000 plants ha^{-1} (Ghanti *et al*., 1982, Tendaj and Kuzyk, 2001;Kumar and Rawat, 2002). Increasing plant population may increase the yield and profit in cabbage, but high plant density will reduce the head size and head weight (Csizinszky and Schuster, 1985). The quality of any vegetable crop is highly influenced by the fertility level of a particular soil similarly, nutritional quality in cabbage is also highly influenced by fertilization, particularly nitrogen. However, the fluctuation in the rate of fertilizers, especially of N, during recent years requires special attention and determination of the optimal fertilization levels in order to control the increase in the cost of production is needed. It has been accepted that applications of N fertilizer to cabbage increase the yields, plant uniformity, and quality (Kolota *et al.,* 2015).

After studied all the three parameters regarding cabbage production and tally with the present circumstances of cabbage cultivation in West Bengal, the present experiment was conducted at Terai region of West Bengal with the objective to study and standardize the effect of different spacings and levels of nitrogen on growth and yield attributes of cabbage grown under polyethylene film mulch.

MATERIALS AND METHODS

The experiment was carried out at the Horticulture Instructional Farm, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, from November 2017 to January 2018 and November 2018 to January 2019 to study the effect of growth, yield and profitability of cabbage under polyethylene film mulch with different spacings and levels of nitrogen during winter season, under the sub-Himalayan Terai Aro-climatic condition.

Email: tapandas84399@gmail.com

Average annual rainfall of 300 mm, soil of the experimental site was loamy sand in texture with 5.8 pH and 0.54 % organic carbon. The available nitrogen content in the soil was 201.6 kg ha^{-1}, available phosphorus content in the soil was 12.01 kg ha^{-1} and available potassium content in the soil was 91.57 kg ha^{-1}. The experiments were laid out in a Factorial Randomized Block Design with three replications, the levels of nitrogen were viz. 100kg, 150kg and 200kg ha^{-1} as represented by N_1, N_2 and N_3respectively. The plant spacings 45 cm x 30 cm, 45 cm x 45 cm and 45 cm x 60 cm under black polyethylene mulch. Cabbage hybrid (Green express, Sakata Company) seeds were sown on both the year of 15th October 2017 and 2018, and transplanting of 15thNovember, 2017and 2018.Observations on the plant height, plant spread, stem diameter, head length, head width, head stem height, head weight, head efficiency, head dry meter, available NPK in soil, vitamin C, yield per plot and yield per ha^{-1}has been taken replication wise. Statistical analysis of 3^2 Factorial Randomized Block Design was carried used for IBM – SPS- statistic -20 to carry out the experiment at 5% levels of significance.

RESULTS AND DISCUSSION

Effect of different nitrogen level

After conducting the experiment it was receded that both significant and non-significant results was showed in different levels of spacing and nitrogen used along with their interactions. Plant spread of the cabbage recorded non-significant variance of similar report was supported by Pramanik (2007). No significant variation was observed in case of stem diameter; head stem height and head height of cabbage. The highest head width 16.49 cm was recorded in nitrogen level 200 kg ha^{-1} followed by 16.10 kg ha^{-1} in 300 kg ha^{-1} nitrogen level. Paul *et al.* (2015) was found similar type of result after conducting a trial with different nitrogen level. Head weight was recorded significant variation in nitrogen level 150 kg ha^{-1} and maximum head weight 1919.34 g followed by 1774.24 g ha^{-1} in nitrogen level 200 kg ha^{-1}. Similar type of finding also reported by Din *et al.* (2007) was applied of 120 kg ha^{-1} nitrogen gives maximum head weight, and the probable cause of the head weight increase with he nitrogen level may be due to the higher dry matter accumulation in the head of the cabbage. Head dry matter content the different level of nitrogen was recorded non significant variation. Head efficiency is the editable part of cabbage and also recorded significant variation among nitrogen levels with the range of 4.07 to 4.46 %. Days to 50% head formation showed significant variation from 100kg ha^{-1} nitrogen was taken highest 31.39 days and 200kg ha^{-1} nitrogen was taken lowest 29.11 days for 50% head formation. Significant variance of individual plant yield and the maximum head weight (1.57 kg $plant^{-1}$) was found in nitrogen level 200 kg ha^{-1} which is at par with nitrogen level 150 kg ha^{-1}. Yield per plot and yield per hectare were showed significant variation of he both parameter 200 kg ha^{-1} nitrogen. The application of 200 kg ha^{-1} nitrogen Showed maximum result 71.73 kg $plot^{-1}$ and 62.72 ton ha^{-1} respectively. Akand *et al.* (2015) was recorded 150 kg nitrogen per hectare gives higher yield and maximum head width than other level of nitrogen under their study. The variation may be due to the residual nitrogen present in the soil and the soil characteristics also. On the other hand vitamin-A content in 100g fresh weight of cabbage shows non-significant result but vitamin-C was recorded with significant difference among the nitrogen level. Maximum amount of vitamin-C (37.07mg 100g $fresh^{-1}$) was recorded in nitrogen level 100 kg ha^{-1} followed by 31.38 mg 100g $fresh^{-1}$ in case of nitrogen level 150 kg ha^{-1}.

Effect of different spacing level

The second factor of the present experiment was recorded significant results solely among the different spacing applied for the present programme. In case of plant height the maximum (21.63 cm) was secured by the spacing of 45cm x 60 cm, which was at par with the spacing of 45 cm x 45 cm. Ullah *et al.* (2013) and Singh *et al.* (2007) recorded similar type of results and they conclude it may be due to the better accumulation of the nutrient by each and every plant. On the other hand, Plant spread didn't show too much difference between the different spacing levels, it may be due to the genetic construction of the plant itself. The range of plant spread was 41.90cm to 40.94cm. Similarly the stem diameter also didn't show any significant difference among the spacing levels. However, head height was showed significant variation, where the spacing 45 cm x 60 cm recorded maximum (17.15 cm) and the minimum in 45 cm x 30 cm. The probable cause of the difference may be due the inter space competition among the plants for nutrient intake from the soil. Head width and head weight both are the yield decisive factor of cabbage plant. In this present study both the characters were shown significant difference and the spacing 45 cm x 60 cm was recorded maximum in both cases (46.60 cm and 2049.72 g) respectively. Moniruzzaman *et al.* (2011) along with this their results also support the present findings wider spacing was supportive for accumulation of higher dry matter content in head of cabbage and

Table 1: Plant height, plant spread, stem diameter, head height, head width, head stem height and head weight of cabbage under polyethylene mulch with spacing and N management in Tarei region of West Bengal.

Treatment	Plant height (cm)	Plant spread (cm)	Stem diameter (mm)	Head height (cm)	Head width (cm)	Head stem height (cm)	Head weight (gm)
NITROGEN							
N_1	20.99	41.10	16.95	16.42	16.07	8.13	1714.40
N_2	21.29	42.04	17.21	17.00	16.49	7.93	1919.34
N_3	21.20	40.89	17.03	16.51	16.10	7.88	1774.24
SEm±	**0.21**	**0.56**	**0.219**	**0.19**	**0.15**	**0.19**	**52.97**
LSD(0.05)	**NS**	**NS**	**NS**	**0.54**	**NS**	**NS**	**152.60**
SPACING							
S_1	21.04	41.17	16.98	16.25	15.73	7.83	1648.47
S_2	20.81	41.90	17.07	16.53	16.33	8.34	1709.78
S_3	21.63	40.94	17.12	17.15	16.60	7.76	2049.72
SEm±	**0.21**	**0.56**	**0.219**	**0.19**	**0.15**	**0.19**	**52.97**
LSD(0.05)	**0.61**	**NS**	**NS**	**0.54**	**0.42**	NS	**152.60**
NITROGEN X SPACING							
N_1S_1	21.53	42.65	16.73	15.94	15.32	8.17	1490.11
N_1S_2	20.49	40.60	16.45	16.45	16.20	8.73	1694.85
N_1S_3	20.95	40.05	17.64	16.86	16.68	7.47	1958.24
N_2S_1	20.55	40.00	16.88	16.72	16.31	7.56	1780.23
N_2S_2	20.86	44.51	17.77	16.31	16.24	8.32	1693.23
N_2S_3	22.46	41.60	16.95	17.96	16.91	7.91	2284.55
N_3S_1	21.05	40.87	17.33	16.08	15.55	7.77	1675.06
N_3S_2	21.07	40.60	16.97	16.83	16.56	7.96	1741.27
N_3S_3	21.48	41.19	16.77	16.64	16.21	7.92	1906.38
SEm±	**0.37**	**0.96**	**0.38**	**0.32**	**0.25**	**0.34**	**91.75**
LSD(0.05)	**1.06**	**2.77**	**NS**	**NS**	**NS**	**NS**	**NS**
CV %	**4.28**	**5.71**	**3.85**	**4.74**	**3.80**	**10.32**	**12.47**

Levels of nitrogen- N_1=100 kg ha^{-1}, N_2=150 kg ha^{-1}, N_3= 200 kg ha^{-1}, Spacing- S_1=45 cm row to row x 30 cm plant to plant, S_2=45 cm row to row x 45 cm plant to plant S_3= 45 cm row to row x 60 cm plant to plant

increase the weight of single head. Head efficiency is another factor which effects the marketable yield. In present experiment head efficiency showed significant variation and maximum was recorded in spacing of 45 cm x 30 m (4.52 %) followed by 45 cm x 45 cm (4.14 %). The head dry matter content was recorded without any significant variation. Days to 50 per cent head formation and maturity showed significant variation among different spacing levels and in both cases early maturity was recorded in spacing 45 cm x 60 cm (30.1 days and 69.9 days, respectively). The per plant production was highest in spacing 45cm x 60cm due to better accumulation of photosynthates. But in case of plot yield and per hectare yield the maximum harvest was recorded in spacing 45 cm x 30 cm (83.03 kg plot^{-1} and 72.84 ton ha^{-1}, respectively) due to the better plant density. Khan *et al*. (2015) and Sarker *et al.* (2002) reported similar finding of higher yield with the closer spacing, it may be due to the increase of the number of plants as well as head of cabbage in specific area within specific time period. But Ullah *et al.* (2012) and Haque *et al*.(2015) reported that wider spacing produced highest marketable yield, it may be cause of better accumulation of dry matter in heads of cabbage. In case of biochemical parameters, vitamin-A content didn't show significant variation but highest vitamin-C content was recorded in spacing 45 cm x 30 cm.

Effect of interaction between different nitrogen and spacing levels

The interaction effect of different nitrogen and spacing levels under black polythene mulch was

Table 2: Head efficiency, head dry content, days to 50% head formation, days to 50% head maturity, yield/ plant, yield plot^{-1}, yield ha^{-1} of cabbage under polyethylene mulch with spacing and N management in Terai region of West Bengal

Treatment	Vitamin A (mg 100g^{-1})	Vitamin C (mg 100g^{-1})	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})
NITROGEN					
N_1	0.036	37.07	145.23	27.48	155.34
N_2	0.039	32.49	157.50	28.66	157.32
N_3	0.043	31.38	168.65	28.84	161.24
SEm±	**0.003**	**0.48**	**0.64**	**0.08**	**0.57**
LSD(0.05)	**NS**	**1.38**	**1.85**	**0.24**	**1.64**
SPACING					
S_1	0.035	37.21	154.08	27.79	155.84
S_2	0.038	33.18	157.01	28.28	157.56
S_3	0.045	30.55	160.28	28.93	160.51
SEm±	**0.003**	**0.48**	**0.64**	**0.08**	**0.57**
LSD(0.05)	**NS**	**1.38**	**1.85**	**0.24**	**1.64**
NITROGEN X SPACING					
N_1S_1	0.034	40.82	141.75	26.96	153.52
N_1S_2	0.039	35.82	144.88	27.51	155.28
N_1S_3	0.036	34.57	149.06	27.98	157.23
N_2S_1	0.039	35.41	153.87	27.69	155.88
N_2S_2	0.038	32.91	157.85	28.60	157.44
N_2S_3	0.040	29.16	160.77	29.70	158.65
N_3S_1	0.033	35.41	166.63	28.71	158.13
N_3S_2	0.037	30.82	168.30	28.72	159.97
N_3S_3	0.058	27.91	171.02	29.11	165.64
SEm±	**0.006**	**0.83**	**1.11**	**0.14**	**0.99**
LSD(0.05)	**NS**	**NS**	**NS**	**0.42**	**NS**
CV%	**36.69**	**6.02**	**1.74**	**1.25**	**1.53**

Levels of nitrogen- N_1=100 kg ha^{-1}, N_2=150 kg ha^{-1}, N_3= 200 kg ha^{-1}, Spacing- S_1=45 cm row to row x 30 cm plant to plant, S_2=45 cm row to row x 45 cm plant to plant S_3= 45 cm row to row x 60 cm plant to plan

recorded non-significant variation for the most of the characters under study except plant height, plant spread and head efficiency. Highest plant height (22.46 cm) was recorded in the interaction of 150 kg nitrogen per hectare with 45 cm x 60 cm spacing, which was at par with 100 kg nitrogen per hectare and 45 cm x 30 cm spacing (21.53 cm) and 200 kg nitrogen per hectare with 45 cm x 60 cm spacing (21.48cm). Plant spread was recorded maximum (44.51 cm) in interaction between 150 kg nitrogen per hectare with 45 cm x 45 cm spacing, which was at par with 100 kg nitrogen per hectare and 45 cm x 30 cm spacing (42.65 cm). Stem diameter, head height, head width, and head weight of the cabbage plant were not effected by interaction between the different nitrogen and spacing levels. On the other hand, head efficiency recorded significant variation among the interactions under this study and the interaction between100 kg nitrogen per hectare and 45 cm x 30 cm spacing recorded highest head efficiency (4.95 %). Other morphological characters *viz.* head dry content, days to 50 per cent head formation and maturity, and yield in respect to per plant, per plot and per hectare were shown non-significant variation for interaction effect.The biochemical characters *viz.* vitamin-A and vitamin-C also didn't show any significant variation. Haque *et al.*(2015) reported significant difference in case of head weight and fresh yield among the different spacing level with the interaction of nitrogen levels under their study, this dissimilarities with the present experiment may be due to the difference in agro-climactic condition of the place where study, soil characters and other environmental factors.

Table 3: Vitamin A, Vitamin C, Nitrogen, Phosphorus, Potassium of cabbage under polyethylene mulch with spacing and N management in Terai region of West Bengal

Treatment	Head efficiency (%)	Head dry content (%)	Days to 50% head formation	Days to 50% head maturity	Yield plant^{-1} (kg)	Yield plot^{-1} (kg)	Yield ha^{-1} (ton)
NITROGEN							
N_1	4.46a	4.93	31.39	72.72	1.43	61.02	53.36
N_2	4.04b	5.07	30.44	70.50	1.54	69.17	60.49
N_3	4.07b	5.07	29.11	69.61	1.57	71.73	62.72
SEm±	**0.09**	**0.27**	**0.10**	**0.09**	**0.04**	**2.05**	**1.80**
LSD(0.05)	**0.27**	**NS**	**0.29**	**0.27**	**0.12**	**5.92**	**5.17**
SPACING							
S_1	4.52	4.93	30.61	71.89	1.30	83.30	72.84
S_2	4.14	5.07	30.28	71.00	1.50	64.14	56.09
S_3	3.92	5.07	30.06	69.94	1.73	54.47	47.64
SEm±	**0.09**	**0.27**	**0.10**	**0.09**	**0.04**	**2.05**	**1.80**
LSD(0.05)	**0.27**	**NS**	**0.29**	**0.27**	**0.12**	**5.92**	**5.17**
NITROGEN X SPACING							
N_1S_1	4.95	5.44	31.67	73.83	1.28	75.21	64.43
N_1S_2	4.61	4.58	31.17	72.83	1.38	59.08	51.32
N_1S_3	3.84	4.76	31.33	71.50	1.64	54.92	44.32
N_2S_1	4.21	5.68	30.67	71.33	1.27	92.15	74.64
N_2S_2	3.90	5.04	30.33	70.50	1.60	67.80	58.35
N_2S_3	4.02	4.48	30.33	69.67	1.75	60.33	48.47
N_3S_1	4.39	5.31	29.50	70.50	1.36	**103.08**	**79.46**
N_3S_2	3.91	5.39	29.33	69.67	1.54	71.03	58.60
N_3S_3	3.91	4.52	28.50	68.67	1.80	61.54	50.11
SEm±	**0.16**	**0.46**	**0.18**	**0.16**	**0.07**	**6.26**	**3.11**
LSD(0.05)	**0.47**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CV%	**9.44**	**22.51**	**1.42**	**0.55**	**11.26**	**15.13**	**12.94**

Levels of nitrogen- N_1=100 kg ha^{-1}, N_2=150 kg ha^{-1}, N_3= 200 kg ha^{-1}, Spacing- S_1=45 cm row to row x 30 cm plant to plant, S_2=45 cm row to row x 45 cm plant to plant S_3= 45 cm row to row x 60 cm plant to plan

Table 4: Total cost of production, gross return, net profit and benefit cost of cabbage under polyethylene mulch with spacing and N management in Terai region of West Bengal

Treatments	Total cost of production Mean	Gross return (Rs) Mean	Net profit (Rs) Mean	Benefit Cost ratio Mean
N_1S_1	114996.7	386610	271613	2.36
N_1S_2	110582.9	307890	197307	1.79
N_1S_3	113679.1	265950	152271	1.34
N_2S_1	110569.7	447870	337300	3.07
N_2S_2	106155.9	350100	243944	2.30
N_2S_3	109252.1	290850	181598	1.67
N_3S_1	113652.7	476760	363107	3.21
N_3S_2	109238.9	351600	242361	2.22
N_3S_3	112335.1	300690	188355	1.68

Production economics

After analysis of B : C ratio it can be clearly said that the combinations of 200 kg nitrogen per hectare along with 45cm x 30cm spacing gave more profitable return than the other treatment combinations of nitrogen and spacing. The highest B:C ratio *i.e*. 3.21 was near about three times higher than the least one.

Based on experiment at results, it can be concluded that the different nitrogen and spacing level solely had tremendous effect on growth and yield of cabbage, but their interaction effect didn't show much significant effect under black polythene mulch. Therefore, cultivation of cabbage with 200 kg nitrogen per hectare and 45cm x 30 cm spacing may be helpful for getting higher yield and it may be recommended for cultivation of cabbage under black polythene mulch in Terai Agro-ecological region of West Bengal.

REFERENCES

Bhardwaj, R. L. 2011. Bench mark survey on effect of mulching material on crop production. Krishi Vigyan Kendrs, Sirohi, MPUAT Udaipur, 12-15.

Csizinszky, A.A., and Schuster, D.J. 1985. Response of cabbage to insecticide schedule, plant spacing, and fertilizer. *J. Amer. Soc. Hort. Sci.*, **110** (**6**): 888-893

Din, M., Qasim, M. and Alam, M. 2007. Effect of different levels of N, P and K on the growth and yield of cabbage. *J. Agric. Res*.,**45**:171-176.

Ghanti, P., Sounda, G., Jana, P. K. and Som, M.G. 1982. Effect of levels of nitrogen, phosphorus and spacing on yield characters of cabbage. *Veg. Sci*.,**9**: 1-4

Annual Reports of National Horticulture Board, Government of India, New Delhi. (2018)

Haque, F. A., Islam, N., Islam, M. N., Ullah, A. and Sarkar, M.D. 2015. Growth, yield and profitability of cabbage (*Brassica oleracea* L.) as influenced by applied nitrogen and plant spacing. *Agriculturists*., **13**(1):35-45.

Khan, F., Khan, T. U., Namatullah, S. and Tajudin, 2015. Vegetative growth of cabbage in relation to sowing time, plant spacing and npk grown under different localities of azadkashmir and gilgit-baltistan. *ARPN J. Agric. Biol. Sci.*,**10**(1):1990-6145.

Kumar, M. and Rawat, T.S. 2002.Effect of nitrogen and spacing on the quality and yield of cabbage (*Brassica oleracea*L. Var. capitata). *Agric. Sci. Digest*, **22**(2): 90-92.

Moniruzzaman, M. 2011.Effect of plant spacings on the performance of hybrid cabbage (*Brassica oleracea* var. capitata) varieties. *Bangladesh J. Agric. Res*., **36**(3) :495-506.

Paul, J., Akand, M. H., Mazed, H. E. M. K.,M. Azed, K., Md. Pulok, M.A.I. and Partho, S.G. 2015. Influence of different doses of nitrogen on the growth and yield of cabbage *(Brassica oleracea* var. capitata l.) *Int. J. Multidisciplinary Res. Dev.,* **2**(2): 11-14

Sarker, M.Y., Azad, A.K., Hasan, M.K, Nasreen A., Naher, Q. and Baset, M.A. 2002. Effect of plant spacing and sources of nutrients on the growth and yield of cabbage. *Pakistan J. Biol. Sci.*, **5**(6), 636-639.

Singh, J.P., Munib, K., Rakshanda, M. 2007. Effect of nitrogen levels and spacing on the growth and yield of cabbage. *Environ. Ecol.*, **25**(1): 153-155.

Paramanik, S.H.I.L.A. 2007. Effect of nitrogen and phosphorus on the growth and yield of cabbage (*Brassica oleraceae* var. *capitata* L.) Doctoral dissertation, MS thesis, Sher-e Bangla Agricultural University

Tendaj, M. and Kuzyk, K. 2001. Effect of plant density on yielding of red cabbage. *Veg. Crop. Res. Bull.*, **54**(2).

Kolota, E. and Chohura, P. 2015.Control of head size and nutritional value of cabbage by plant population and nitrogen fertilization. *Acta Scientiarum Polonorum Hortorum Cultus*, **14** (2):75-85

Ullah, A., Islam, M.N., Hossain, M.I., Sarkar, M.D. and Moniruzzaman, M. 2013. Effect of planting time and spacing on growth and yield of cabbage. *Int. J. Bio-res. Stress Management.*, **4**(2):182-186.

Ullah, S., Skidmore, A. K., Naeem, M. and Schlerf, M. 2012. An accurate retrieval of leaf water content from mid to thermal infrared spectra using continuous wavelet analysis. *Science of The Total Environment*., **437**: 145-152.

Van Derwerken, J.E. and Wilcox-Lee, D. 1988. Influence of plastic mulch and type and frequency of irrigation on growth and yield of bell pepper. *Amer.n Soc. Hort. Sci.,***23**(6): 985-988