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Effect of date of transplanting and mulching on growth, yield and quality of onion (*Allium cepa* L.) cv. Nasik Red

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Abstract: A field experiment was conducted during *rabi* season of 2014-2015 at Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow-226025 (U.P.) India to find out the effect of different dates of transplanting and mulching on growth, yield and quality of onion (*Allium cepa* L.) cv. Nasik Red. There were 16 treatments comprising 4 dates of transplanting (15th November, 1st, 15th and 30th December) and 3 mulching (saw dust, rice husk and wheat straw) while, without mulching as control and laid out under two factor RBD with three replications. The study clearly revealed that there were significant effects of all treatments on vegetative growth, yield and quality attributes of onion. Plant height (65.34 cm), number of leaves per plant (8.89), length of leaves (56.07 cm), neck thickness (18.75 mm), yield (5.166 kg/plot and 387.46 q/ha) were found maximum at 1st December planting with wheat straw mulching (T_7). The best quality bulb in respect of maximum neck thickness (12.35 mm), basal diameter (13.61.mm), diameter of bulb (54.41 mm polar and 64.15 mm equatorial), length of bulb (65.17 mm), number of scales per bulb (9.24), bulb moisture (85.06 %) T.S.S. (13.84 ^{o}Brix), ascorbic acid (10.47 mg/100g), total sugars (10.39 %) etc. were also obtained when mulching was done with wheat straw and transplanted on 1st December (T_7) followed by T_6 (planted on 1st December and mulching with rice husk). The study clearly concluded that i.) mulching is good for production of onion, ii.) late transplanting on 30th December showed very poor performance irrespective of mulching and iii) transplanting on 1st December and mulching with wheat straw was the best combination for getting good quality yield of onion.

Keywords: Date of transplanting, Mulching, Onion, Quality, Yield

INTRODUCTION

Onion *(Allium cepa* L.) is one of the most important commercial bulbous vegetable as well as spice crops. According to Hasegawa *et al*. (2001), it is originated at Central Asia and is cultivated in many countries around the world. Onion is the second most important vegetable crop after tomatoes in terms of income generation (Griffiths *et al.*, 2002; Mallor *et al.*, 2011). The name "*wild onion*" is applied to a number of *Allium* species but *A. cepa* is exclusively known from cultivation and its ancestral wild original form is not known, although escapes fruit cultivation have become established in some regions. However, Zohary and Hopf (2000) stated that "there are doubts whether the *A. vavilovii* collections tested represent genuine wild material or only feral derivatives of the crop". It is a short duration and quick growing herb having various uses such as vegetables, spices and for medicines. It promotes appetite and is useful against malaria, night blindness which also lowers blood pressure (Perane, 2001). India is the second largest producer of onion next to China accounting for 20 percent of the world area and 10 percent of the world production having annual production of 18736'000 MT from 882'000 HA area and productivity of 21.2 MT/HA. The major onion growing states of India are Maharastra, Karnataka, Madhya Pradesh, Andhra Pradesh, Bihar, Gujarat, Punjab and Tamil Nadu (Anonymmous, 2014). At present, Maharashtra is the leading state in onion production having an area of 1.21 lakh hectares with production of 14.23 lakh MT (Anonymmous, 2015). Nasik district alone contributes approximately 30% of production of state and 70% of total onion exported from India is from Maharshtra state.

Allium is characterized by the presence of remarkable S containing compound (allyl propyle di sulphide) which gives it a distinctive smell and pungency. It also has an antibacterial, antiseptic (Duke and Ayensu, 1994) and antifungal characteristics. Onion bulb is a rich source of minerals like phosphorus, calcium, carbohydrates and protein (Aykroyd, 1963). Bulb juice is used as smelling agent for hysterical fits and faintness. It is a favourable because of its volatile flavours (containing sulphur) released during tissue disruption (Abbey and Joyce, 2004). Onion is used in the stomach disorder and prevention the children to 'lu' and 'Kalra' in summer season. Small sized onions

are more nutritive than large sized onions. The performance of an onion cultivar depends on the interaction between genotype and the environment (Jilani and Ghaffoor, 2003). This interaction mainly determines cultivar selection for a specific area. On the other hand, agronomic practices such as sowing date, fertilization, irrigation and plant population among others, also have an effect on the growth, yield and quality of onion bulbs (Brewster, 2008). In other words, under favorable conditions, higher yield may be obtained in a shorter growing season. So, it is very important to find a suitable time of planting for higher yield and quality. Planting at proper time has a pronounced effect on the growth, yield and quality production of onion (Singh and Korla, 1991), but, it may vary region to region. Research findings from different countries suggested that time of planting and varieties/accessions have a profound effect on the growth and yield of onion. Another important practice is mulching which helps to retain soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops **(**Maji and Das, 2008 a, b). Mulching may be natural or artificial. It may be natural or artificial. For the past decades people are more concern about the organically produced foods (Maji, 2013). So, use of natural organic mulching is now getting popularity. Mulching conserves soil moisture from 2.1-2.8% more than non-mulched one. Mulching also manage weeds which are serious problem in onion which limits the crop yield and decreased profits. Mulching using paddy straw, saw dust, neem leaves were observed to suppress weed growth effectively in onion (Umar *et al*, 2000). Keeping this in view, the present experiment was carried out to study the effect of different dates of planting and organic mulching on growth, yield and bulb quality of onion (*Allium cepa* L.)

MATERIALS AND METHODS

The experiment was conducted using onion cultivar Nasik Red during the *rabi* season of 2014-2015 at the Horticulture Research Farm, Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow (Utter Pradesh) India to find out the effect of date of transplanting and mulching on growth, yield and quality of onion. A total of sixteen treatments including control were laid out in Factorial (two factors) Randomized Block Design (RBD) with three replications. Experimental site was at $80^0 52'$ East longitude and $26^0 50'$North latitude and altitude of 123 meter above mean sea level (MSL) with dry subtropical climate (29-45^0 C in summer and minimum temperature from 2^0C to 12^0C in winter and relative humidity of 50-77%) having sandy loam soil slightly alkaline in reaction. The treatments included 4 dates of planting (15^{th} November, 1^{st}, 15^{th} and 30^{th} December) and 3 mulching (saw dust, rice husk, wheat straw) while without mulching as control. Mulching materials were collected from local market. Wheat straw was chopped and the mulch materials were spread over soil at least 1.5 – 2 inch thickness according to the respective treatments. Seeds of the onion (*Allium cepa* L.) cv. Nasik Red were collected from NHRDF Centre, Deoria (U.P.). Bulbs of Nasik Red are attractive dark red in color. It is very popular among frames in North India because of its attractive bronze red and better performance, mature in 110-120 days after transplanting and thus, recommend for cultivation in Northern, Central and Western India during Rabi season. Seedlings were raised in nursery beds, 1.0 m wide and of convenient length nicely prepared by mixing fully decomposed FYM (3-4 kg/m^2). Nursery beds were raised 15-20 cm in order to allow proper drainage of water. The seeds were sown in rows at 10 cm distance at shallow depth, 1.0 cm apart and then lightly covered with finely sieved leaf mould. Healthy seedlings of 10 to 15 cm height with 3 to 4 leaves were transplanted. The data were recorded for vegetative growth, yield and quality attributes control such as, plant height (cm), number of leaves per plant, length of leaves (cm), neck thickness (mm),yield per plot (kg), yield per hectare (q), neck thickness (mm), basal diameter (mm), polar diameter (mm), equatorial diameter (mm), length of bulb (mm), number of scales per bulb, bulb moisture (%)T.S.S. (^{o}Brix), ascorbic acid (mg/100g), total sugars (%), reducing sugar (%), non-reducing sugar (%) etc. worked out from each pot. The chemical analysis was done following the standard methods as stated by AOAC (2000). The collected data was statistically analyzed by following the standard procedure of ANOVA as stated by Panse and Sukhatme (1985) and the treatment effects were compared at 5% level of significance.

RESULTS AND DISCUSSION

Effect of date of transplanting and mulching on vegetative growth characters of onion: The experimental results (Table 1) showed that the use of different date of transplanting and mulching increased plant height significantly. Among the treatments without mulching, it was seen that first date of transplanting at 15^{th} November (T_4) showed the highest (62.20cm) plant height at 30 days after transplanting (DAT). However, the plant height was found maximum under treatment T_6 at 30 DAT among the all treatments combining with mulching. While, at 60 and 90 DAT, T_7 (transplanting at 1^{st} December with chopped wheat straw mulching) recorded the highest plant height (54.15 cm and 65.34 cm, respectively). The minimum plant height was noted at 30, 60, and 90 DAT (23.97 cm, 50.99 cm and 62.20 cm, respectively) in the untreated control**.** The maximum number of leaves per plant at 30 DAT was observed in the treatment T_6 (first

Table 1. Effect of different dates of planting and mulching on vegetative growth of onion.

Treatments	Plant height (cm)			Number of leaves per plant			Length of leaves (cm)			Neck thickness (mm)		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T_0 - (D_0M_0)	23.97	50.99	62.20	4.25	6.28	8.45	18.48	40.83	51.14	6.51	16.27	17.90
T_1 - (D_0M_1)	24.99	52.98	64.19	4.57	6.48	8.57	20.49	46.19	3.95	6.67	16.68	18.35
T_2 - (D_0M_2)	24.97	52.95	64.09	4.69	6.62	8.59	20.47	44.79	54.55	6.64	16.61	18.27
T_3 - (D_0M_3)	24.83	52.63	63.84	4.85	6.53	8.65	20.33	44.50	52.05	6.79	17.05	18.75
T_4 - (D_1M_0)	23.98	50.99	62.20	4.22	6.52	8.43	20.05	41.34	52.72	6.37	15.92	17.51
T_5 - (D_1M_1)	24.55	52.11	63.32	4.61	6.47	8.49	19.47	44.81	55.78	6.82	15.51	17.06
T_6 - (D_1M_2)	25.59	52.92	64.13	4.88	6.58	8.83	21.09	45.50	55.86	6.79	16.98	18.67
T_7 - (D_1M_3)	24.96	54.15	65.34	4.68	6.76	8.89	20.46	46.46	56.07	6.20	17.05	18.75
T_8 - (D_2M_0)	23.08	49.21	60.46	4.53	5.90	7.71	18.58	39.15	48.11	6.19	15.47	17.02
T_9 - (D_2M_1)	23.63	50.32	61.51	4.46	5.55	7.62	19.13	39.43	48.92	6.69	16.73	18.41
T_{10} - (D_2M_2)	23.99	51.03	62.24	4.59	5.52	7.55	19.49	41.15	49.19	6.72	16.79	18.47
T_{11} - (D_2M_3)	23.93	50.95	62.19	4.66	5.44	7.58	19.46	42.46	49.59	6.53	16.31	17.94
T_{12} - (D_3M_0)	22.98	49.06	57.54	3.41	5.36	7.52	19.47	38.82	46.62	5.66	13.92	15.17
T_{13} - (D_3M_1)	22.92	48.87	60.08	3.63	5.65	7.72	18.38	37.47	46.92	5.78	14.27	15.55
T_{14} - (D_3M_2)	21.65	46.46	56.53	3.57	5.55	7.72	17.15	36.49	47.92	5.72	13.93	15.19
T_{15} - (D_3M_3)	22.64	48.36	59.61	4.48	5.61	7.56	18.14	37.15	46.28	5.64	13.99	15.25
SEm (±)												
D	0.57	0.53	0.44	0.39	0.84	0.72	0.55	0.56	0.65	0.55	0.55	0.57
M	0.27	0.26	0.01	0.18	0.30	0.09	0.24	0.21	0.04	0.18	0.12	0.12
DXM	0.15	0.14	0.01	0.07	0.25	0.07	0.13	0.11	0.03	0.19	0.07	0.07
CD (P=0.05)												
D	1.18	1.10	0.93	0.82	1.76	1.49	1.16	1.16	1.35	1.14	1.14	1.18
M	0.57	0.54	0.03	0.37	0.62	0.20	0.49	0.43	0.09	0.37	0.26	0.25
DXM	0.67	0.59	0.03	0.30	1.10	0.29	0.57	0.50	0.12	0.42	0.29	0.30

T_0 -15th November + no mulching, T_1 - 15th November + saw dust mulching , T_2 - 15th November + rice husk mulching, T_3 -15th November + wheat straw mulching, T_4 - 1st December + no mulching, T_5 - 1st December + saw dust mulching, T_6 - 1st December + rice husk mulching, T_7 - 1st December + wheat straw mulching, T_8 - 15th December + no mulching, T_9 - 15th December + saw dust mulching, T_{10} - 15th December + rice husk mulching, T_{11} - 15th December + wheat straw mulching, T_{12} - 30th December + no mulching, T_{13} - 30th December + saw dust mulching, T_{14} - 30th December + rice husk mulching, T_{15} - 30th December + wheat straw mulching.

Table 2. Effect of various dates of planting and mulching on bulb yield and physical quality of onion.

Treatments	Yield Per plot (kg)	Yield (q/ha)	Basal diameter of bulb (mm)	Polar diameter of bulb (mm)	Equatorial diameter of bulb (mm)	Length of bulb (mm)
T_0 -15th November + no mulching	4.965	372.34	11.36	47.24	59.19	59.96
T_1 -15th November + saw dust mulching	5.121	384.05	13.24	53.33	62.74	62.87
T_2 -15th November + rice husk mulching	5.072	380.41	13.13	53.15	63.21	63.85
T_3 -15th November + wheat straw mulching	5.145	385.90	13.11	53.18	63.60	64.47
T_4 -1st December + no mulching	5.015	376.11	11.65	50.96	60.21	61.17
T_5 -1st December + saw dust mulching	5.119	383.90	12.66	54.31	64.09	64.47
T_6 -1st December + rice husk mulching	5.133	385.01	12.08	53.79	63.78	64.42
T_7 -1st December + wheat straw mulching	5.166	387.46	13.61	54.41	64.15	65.17
T_8 -15th December + no mulching	3.030	227.22	9.42	46.82	57.29	58.09
T_9 -15th December + saw dust mulching	3.310	248.26	12.45	48.52	58.15	59.22
T_{10} -15th December + rice husk mulching	3.272	245.41	12.80	48.19	58.15	58.82
T_{11} -15th December + wheat straw mulching	3.271	245.31	12.40	49.00	59.17	60.14
T_{12} -30th December + no mulching	2.191	164.30	9.11	38.47	48.34	49.57
T_{13} -30th December + saw dust mulching	2.278	170.84	11.04	42.15	51.90	52.49
T_{14} -30th December + rice husk mulching	2.287	171.53	10.61	41.55	51.19	51.85
T_{15} -30th December + wheat straw mulching	2.309	173.15	10.91	42.16	51.86	52.51
SEm (±)						
D	1.12	1.12	0.35	0.78	0.78	0.76
M	0.07	0.07	0.05	0.01	0.08	0.11
DXM	0.07	0.07	0.02	0.01	0.06	0.09
CD (P=0.05)						
D	2.35	2.35	0.73	1.63	1.62	1.59
M	0.14	0.14	0.11	0.02	0.17	NS
DXM	0.32	0.32	0.08	0.04	0.28	NS

date of transplanting with rice husk mulching, while, it was maximum under T_4 at 60 DAT (considering without mulching) and under T_7 with wheat straw mulching (considering treatment with mulching). Similarly, the minimum length of leaves was also recorded under T_4 as without mulching and T_6 with rice husk mulching at 30 DAT. But, at 60 and 90 DAT the highest length of leaves (46.46 cm, and 56.07 cm, respectively) was observed in the treatment T_7 (transplanting at 1st December with chopped wheat straw mulching). Rahman *et al*. (2013), Raut *et al*. (2009) also found that mulching with water hyacinth increased the growth and yield of onion followed by rice straw mulch.

The neck thickness (Table 1) was measured maximum

Table 3. Response of various dates of planting and mulching on bulb quality of onion.

Treatments	TSS (^{0}B)	Total sugars (%)	Reducing sugar (%)	Non reducing sugar (%)
T_0 - 15th November + no mulching	11.73	8.81	4.78	4.03
T_1 -15th November + saw dust mulching	12.61	9.97	5.49	4.47
T_2 -15th November + rice husk mulching	13.74	10.08	5.88	4.20
T_3 -15th November + wheat straw mulching	13.37	10.19	5.88	4.31
T_4 -1st December + no mulching	12.80	8.38	4.73	3.66
T_5 -1st December + saw dust mulching	12.93	9.28	5.19	4.09
T_6 -1st December + rice husk mulching	13.57	10.16	5.69	4.47
T_7 -1st December + wheat straw mulching	13.84	10.39	5.91	4.48
T_8 -15th December + no mulching	11.93	8.36	4.78	3.58
T_9 -15th December + saw dust mulching	11.99	9.26	5.51	3.74
T_{10} -15th December + rice husk mulching	12.74	9.48	5.40	4.09
T_{11} -15th December + wheat straw mulching	11.88	9.09	5.43	3.65
T_{12} -30th December + no mulching	11.61	8.12	4.60	3.52
T_{13} -30th December + saw dust mulching	11.14	8.58	5.02	3.56
T_{14} -30th December + rice husk mulching	11.58	8.88	5.30	3.58
T_{15} -30th December + wheat straw mulching	12.17	8.59	5.00	3.59
SEm (±)				
D	0.41	0.39	0.26	0.29
M	0.16	0.07	0.18	0.27
DXM	0.07	0.03	0.05	0.08
CD (P=0.05)				
D	0.85	0.82	0.55	0.60
M	0.34	0.14	0.38	0.57
DXM	0.29	0.12	0.21	0.34

under T_5 at 30 DAT, but it increased better at later stage of growth by T_7 at 60 and 90 DAT among all treatments under study. It was found that T_7 and T_6 proved to be the best for vegetative growth. Whereas, the late planting had bad effect on growth. The late planting with or without mulching sometimes showed performance even poorer that control.

The increase in plant height, number of leaves, length of leaves and neck thickness of onion under mulching conditions might be due to the availability of more amount of soil moisture, temperature and humidity due to mulching. It is established that mulching is an advantageous tool for the conserving soil moisture and thus, get the positive and significant result in the case of vegetative growth characters. The yield of onion also depends on vegetative growth before commencement of bulbing (Al-Moshileh, 2007, Derawadan et al., 2002 and Adekpe *et al.,* 2007) .

When no mulching was considered, the maximum basal diameter (11.65 mm) was recorded under T_4 without application of mulching at first date of transplanting (Table 2). Late transplanting caused deterioration on growth and recorded minimum basal diameter (9.11mm) under T_{12} (Control). Similarly, polar diameter (50.96 mm) was also measured maximum under treatment T_7 fallowed by treatment T_5 (first date of transplanting with saw dust mulching). When mulching was not applied the first date of transplanting (T_4) was found better to get maximum equatorial diameter (60.21 mm) and T_7 (transplanting on 1st December with

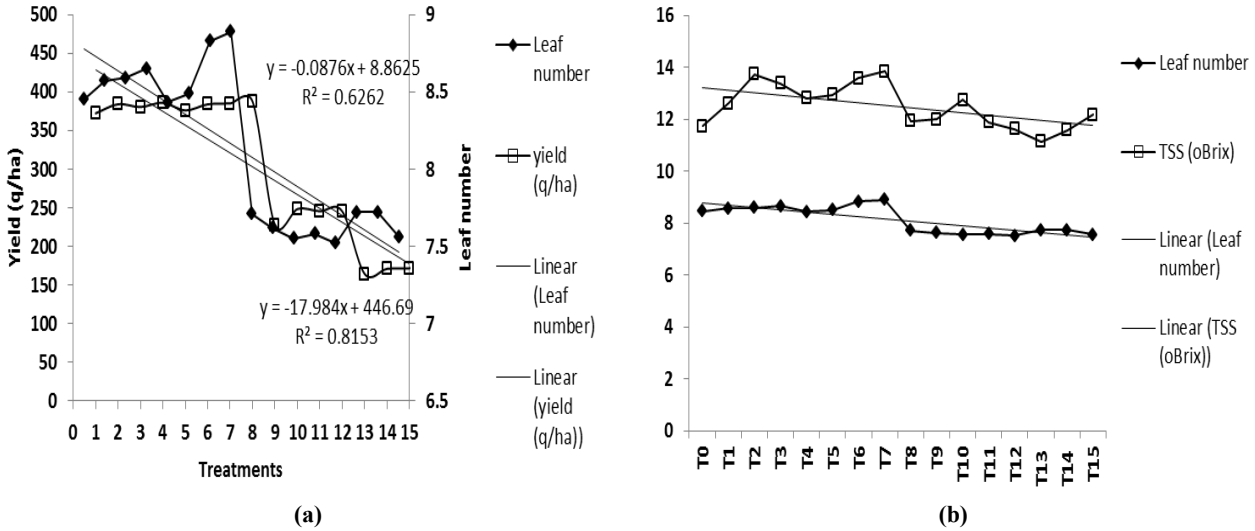

Fig 1. Relation between leaf number with yield (a) and TSS (b)

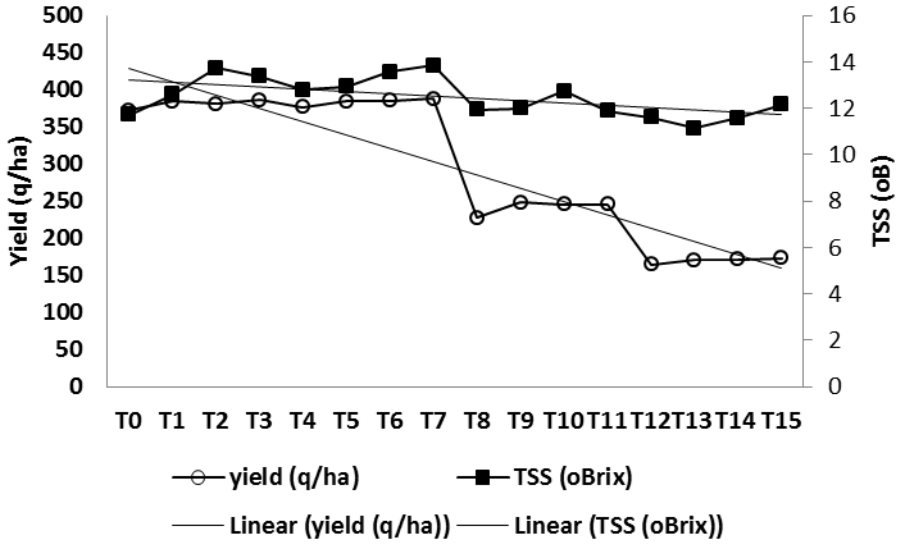

Fig 2. Relation between bulb yield and TSS.

chopped wheat straw mulching) recorded maximum equatorial diameter (64.15 mm). The minimum equatorial diameter was recorded (48.34mm) T_{12} without any mulching at the third date of transplanting which was late. Likewise, the bulb length was found maximum (65.17 mm) under the treatment T_7 (1st December transplanting and wheat straw mulching) and the minimum (49.57 mm) was recorded under T_{12} (without any type of mulching). This result was also supported by the work of Singh (2005) who worked on effect of date of transplanting and spacing on onion and reported that transplanting on 11th October followed by 1st October was the best for higher growth and yield. The mulching with wheat straw and first date of transplanting (T_7) also increased the number of scales per bulb which was maximum (9.27) among all the treatments. Hygrotech (2010) also noted similar trend in production guidelines of onion.

Effect of different date of transplanting and mulching on yield of onion: The data in Table 2 revealed that the highest yield (387.46 q/h) was obtained from T_7 (transplanting on 1st December with chopped wheat straw mulching) followed by T_3 (transplanting on 15th November with chopped wheat straw mulching). The lowest yield (164.30 q/h) was obtained in T_{12} (third date transplanting without mulching).Thus, transplanting on 1st December was better than other date of transplanting irrespective of mulching materials and mulching with wheat straw increased the yield of onion and found as the best when it was done at 1st December (T_7). Gupta and Gupta (1987) also found that mulching and soil moisture retention caused yield of tomato and okra and guava (Maji and Das, 2008 a,b).

Effect of different date of transplanting and mulching on bio-chemical parameters of onion: It was found that highest total soluble solids (13.84°Brix) was

recorded under the treatment T_7 fallowed by T_2. If no mulching was applied then T_4 was better to record the highest TSS (12.80^{o}B). Mulching increased TSS content in general and the better TSS by mulching might be due to more assimilation of nutrients and better soil moisture as observed by Olfati *et al*. (2008) in carrot. Khan et al. (2013) also reported the beneficial effect of soil surface management by mulching while experimented on peanut production. Similarly, ascorbic acid (10.47mg/100 g) content was also increased due to wheat straw mulching at transplanting on 1st December (T_7) and poor performance was found by late transplanting *i.e.* T_{12}. Najafabadia *et al*. (2012) mulching helped to get better yield of garlic in rice field as second crop. Similar trend was also found in case of sugar total sugar reducing and non reducing sugar which were also reported by Mohanty (2001), who observed taller plants with maximum leaves, yield and quality when planted on 15th November. It was also revealed that the TSS and bulb yield were positively correlated with leaf number i.e. vegetative growth in terms of leaf number also enhanced yield and bulb TSS (Fig. 1) whereas, TSS and yield did not follow similar pattern among themselves (Fig. 2). Delay planting affected badly mostly by chilling low temperature at the early stages of growth as well as dry hot summer during bulbing period.

Conclusion

Considering all the performances and recorded observations it might be concluded that the transplanting on 1st December followed by 15th November and in combination with wheat straw mulching (T_7) might be suggested for getting more growth, more as well as good quality bulb. Because transplanting on 1st December with wheat straw mulching helped to produced more vegetative growth, bulb yield and improve quality as compared to other mulching. In respect of date of transplanting, transplanting on 1st December along with chopped wheat straw mulching showed better plant height (65.34 cm at 90 DAT), number of leaves (8.89/plant at 90 DAT), neck thickness (18.75 mm), bulb yield (387.46 q/ha), bulb diameter (13.61 mm), TSS (13.84 ^{0}B), total sugars (10.39 %) etc. compared to all treatments. Delay in transplanting caused negative effect on its growth, yield and quality.

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