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EFFECT OF SOWING DEPTHS, NITROGEN PLACEMENT METHODS AND BIOCHAR ON QUANTITATIVE AND QUALITATIVE ATTRIBUTES OF SUGAR BEET AND ITS WEEDS

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ABSTRACT

Sowing depths and fertilizer application have key roles in sugar beet production. Thus, to quantify the effects of sowing depth, N fertilizer and biochar, experiments were conducted at SCRI Mardan for consecutive two years. Sugar beet variety KWS-1451 was seeded at the rate of 6 kg ha^{-1} at four sowing depths (1cm, 2cm, 3cm and 4cm). Nitrogen at the rate of 140 kg ha^{-1} was either broadcasted or banded in plots having 25 or 50 t biochar ha^{-1}, a control treatment was also included in the experiment. Sowing depths significantly affected the studied parameters except weeds m^{-2}. Sugar beet closed to soil surface showed maximum germination resulted in increased yield production. Mean maximum foliage yield (68.59 t ha^{-1}), beet yield (79.75 t ha^{-1}), total biomass yield 137.27 t ha^{-1}) and sugar yield (12.18 t ha^{-1}) were recorded in sugar beet planted at 2 cm depth. Nitrogen band placement method significantly affected yield productivity of sugar beet. Mean maximum weeds m^{-2} (5.53), foliage yield (71.72 t ha^{-1}), beet yield (83.65 t ha^{-1}), total biomass yield (144.27 t ha^{-1}) and sugar yield (13.30 t ha^{-1}) were obtained by banded fertilizer placement. Biochar integration @ of 50 t ha^{-1} significantly improved soil fertility resulted maximum weeds m^{-2} (5.50), foliage yield (69.61 t ha^{-1}), beet yield (81.90 t ha^{-1}), total biomass yield (143.93 t ha^{-1}) and sugar yield (12.89 t ha^{-1}). The combined application of nitrogen and biochar showed mean maximum weeds m^{-2} (5.53), foliage yield (73.42 t ha^{-1}), beet yield (84.12 t ha^{-1}), total biomass yield (145.61 t ha^{-1}) and sugar yield (11.83 t ha^{-1}) when banded nitrogen was integrated with 50 t ha^{-1} biochar. In conclusion, banded nitrogen having 50 t ha^{-1} biochar at 2 cm depth produced higher yield and represented as the optimum combination for higher production of sugar beet in the study area.

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INTRODUCTION

Sugar beet (*Beta vulgaris* L.) belongs to family Chenopodiaceae. It is locally known as "Chaqandar". It is a biennial and completes its vegetative and reproductive growth in two seasons. In the first season it develops a large fleshy root which stores reserve food, while in the second season it produces flowers and seeds. Sugar beet plant have tape root system, the cone shaped root ranges from 0.8 to 3.5 kg. The size of the beet root depends on plant stand, soil fertility, length of season and freedom from diseases, insect, pest and weeds (Sultan *et al.*, 1999).

Sugar beet is more economical and remunerative crop than sugarcane because it contains 30% more sugar in addition to low fertilizer requirement. As a short duration crop, it provides excellent opportunity for better crop rotation and green forages for livestock. It is cultivated in about 40 countries of the world and accounts for 40-45% of the world sugar production. In Pakistan, it is cultivated on more than 10,000 ha^{-1} acreage. It is successfully grown as a winter crop. The sowing of sugar beet is planted in October, while harvesting starts in the first week of May (Abo-Salama and EL-Sayiad, 2000).

Emergence is influenced by many factors including environmental conditions, seed characteristics and pesticide applications. Temperature, moisture, physical impedance and aeration are recognized as the basic soil environmental factors influencing germination and seedling emergence (Clough *et al*. 2013) Moisture can be managed through irrigation and physical impedance can be changed by planting depth. Sugar beets emergence is reduce by planting depths greater than 2.5cm (Baldock and Smernik, 2002) and herbicide application (Wilson and Smith, 2002). Higher sugar beet yield can be obtained from crop planted at 1.9 cm depth compared to those planted at a 3.2 cm depth (Dean *et al.* 1999).

Placement of fertilizer plays a vital role in higher yield of the crops together with suitable sowing depth. The importance of nitrogen for higher yield has long been documented in Pakistan due to less N contents in soil (Khan *et al.*, 2013). All other nutrients significantly affect the growth and development of plants (Gul *et al.* 2014). The revival of N has been credited to immobilization of N by means of surface application of nitrogenous fertilizer. Broadcast N fertilization results in immobilization, thus banded N below the surface residue layer may be necessary. Shortage of nitrogen leads to decrease protein synthesis, chlorophyll, coenzymes and nucleic acid formation; however, appropriate nitrogen fertilizer use in general increases yields of roots. Nitrogen fertilizer is critical for sugar beet crop, where excess nitrogen not only causes reduction in sugar content in root cells (Stevens *et al.*, 2011) but also accumulates in roots in the form of impurities as toxic nitrogen, which obstruct sugar improvement in the factory.

Nitrogen placements economize N cost and avoid most vulnerable N to losses. N injections provide nutrients according to development of crop. N being motile provides nutrients to roots which develop on both sides of beets (bud grooves). Beets being tapering increased in width and length. The N management do justify vertical increase of beet and sugar production. More N increased impurities and causes hindrances in processing. Close N placement impair seed growth, placement of fertilizer in the vicinity of a beet with in ridges with profound results (Amaducci *et al.*, 2010).

Biochar is a fine grained charcoal high in organic carbon and largely resistant to decomposition. It is produced from pyrolysis of plants and waste feed stocks. Biochar application has received a growing interest as a sustainable technology to improve highly weathered or degraded soils (Lehmann and Rondon, 2006). It enhanced plant growth by improving soil chemical, physical and soil biological properties, all contributing to an increased crop productivity (Lehmann and Rondon, 2006). The net effects on soil physical properties depend on the interaction of the biochar and the management fertilizer application. In addition, biochar is highly recalcitrant to microbial decomposition and thus guarantees a long term benefit for soil fertility (Glaser and Steiner, 2002). Biochar decrease nutrient leaching in soils and enhance nutrient cycling and thus has positive impacts on yield (Stevanato *et al.*, 2010).

Nitrogen placement methods, sowing depth and biochar combinations could boost-up sugar beet yield. Nitrogen is important for early growth, full canopy for light exploitation, sucrose and quality of sugar. Nitrogen excess near to the end of beet harvest reduces sucrose concentration. Nitrogen deficiencies at late harvesting phase (6 weeks) prior to harvest improve quality of beet roots. A good fertility management during early and mid phase of growing season is essential. Therefore the present experiment was designed to investigate the effect of seeding depth, nitrogen placement methods and biochar on the quantitative and qualitative attributes of sugar beet to enhance sugar beet productivity in Mardan region.

MATERIALS AND METHODS

An experiment was conducted at Sugar Crop Research Institute (SCRI) Mardan for consecutive 2011-12 and 2012-13 years respectively in a randomized complete block design with split plot arrangement in four replications. Plot size was 4 x 3.60 m having 6 rows 60 cm apart. Sugar beet variety KWS-1451 was seeded at the rate of 6 kg ha^{-1}. A basal dose of TSP at rate of 120 kg ha^{-1} was applied prior to sowing. Nitrogen @ 140 kg ha^{-1} was applied in the form of urea in two split doses. First dose of nitrogen was applied at sowing stage and second dose was applied at V30 leaf stage. Top of ridges were made flat for desirable seed depths.

The experimental treatments consisted of sowing depths (1, 2, 3 & 4 cm depths), and N fertilizer methods i.e. band and broadcast), integrated with biochar (25 and 50 t ha^{-1}) and a control. Data were collected on foliage yield, beet yield, total biomass yield and sugar yield. The data recorded were analyzed statistically for single and combined over years using analysis of variance techniques using statistical software (statistix v 8.1) appropriate for randomized complete block design with split plot arrangements. The treatment means were compared at ($P \leq 0.05$) level of probability using LSD test (Steel and Torrie, 1997).

RESULTS AND DISCUSSION

Weeds m^{-2}

Sowing depths (SD), nitrogen placement methods (NM), biochar (BC) and NM x BC did not significantly affect weeds m^{-2} (Table-1). Planned mean comparison for weeds m^{-2} among control vs rest was significant during both years ($p<0.01$). Maximum weeds m^{-2} (5.49) were recorded in 4 cm deep plants during first year and 5.46 at 2 cm depth during second year indicating the same mean maximum weeds during both years. Maximum weeds m^{-2} (5.49 and 5.51) were recorded in band placement method during first and second year, respectively. Average weeds were higher (5.50) in band method of nitrogen during both years. Biochar integration @ of 25 and 50 t ha^{-1} showed similar weeds (5.47) during first year; however, weeds were increased from 5.45 to 5.52 during following year. The combined application of banded nitrogen and 50 t ha^{-1} biochar showed maximum weeds m^{-2} (5.53) during both years compared to broadcast having 25 t ha^{-1}.

Foliage yield (t ha^{-1})

The data indicated that foliage yield was significantly affected by sowing depths (SD), nitrogen methods (NM), biochar (BC) combination and interaction between SD x NM and SD x BC; however interaction between NM x BC and SD x NM x BC was non-significant for foliage yield (Table-2). The planned mean comparison for foliage yield among control vs rest was significant during both years ($p<0.01$). Sugar beet plants at 2 cm depth showed maximum foliage yield (65.48 t) during first year which enhanced up to 71.71 t ha^{-1} during second year. Nitrogen band placement with added biochar significantly enhanced foliage yield of sugar beet planted at 2 cm depth. Evans et al. (2009) reported that sugar beet planted at 2.5 cm depth treated with band method of fertilization is a most favorable technique for sugar beet production. Mean maximum foliage yield (68.59 t ha^{-1}) was observed in plants sown 2 cm deep during both years. Band placement method of nitrogen showed considerably higher foliage yield (68.90 and 74.53 t ha^{-1}) during first year and second year, respectively. The higher foliage yield because of banded nitrogen may be due to the fact that banded nitrogen might have customized the development performance indicating more foliage yield. Singh et al. (2010) reported that faction of nitrogen could amplify crop yields of sugar beet. Average higher foliage yield (71.72 t ha^{-1}) was recorded in plants banded with nitrogen. The addition of biochar at the rate of 50 t ha^{-1} made significant difference to foliage yield of sugar beet. Maximum foliage yield (66.43 t) was produced by 50 t ha^{-1} biochar addition during first year which increased up to 72.78 t ha^{-1} with 50 t amended biochar next year. High foliage yield may be due to soaring rate of biochar integration which improved plant performance and resulted in higher foliage yield. Kandil et al. (2002b) confirmed that bio-fertilization brought out considerable variations on foliage yield in sugar beet. The average foliage yield (69.61 t ha^{-1}) was produced by 50 t ha^{-1} biochar during both years. The amalgamation of banded nitrogen and biochar showed maximum foliage yield of 69.23 and 77.61 t ha^{-1} during first and second year, respectively. The average higher yield of this blend was 73.42 t ha^{-1} during both years.

Beet yield (t ha^{-1})

Mean values of the data indicated that beet yield was significantly affected by sowing depths, nitrogen methods, biochar addition with their interactions between SD x NM and SD x NM x BC; however interaction between NM x BC and SD x BC showed non-significant effects for beet yield (Table-3). The planned mean comparison for beet yield among control vs rest was significant during both years ($p<0.01$). Sugar beet plants sown at 2 cm depth gave higher beet yield (79.42 t ha^{-1}) in first year which enhanced up to 80.08 t ha^{-1} in second year indicating average beet yield of 79.75 t ha^{-1} during both years. Banded fertilizer application with integration of biochar significantly increased beet yield when the crop was planted at 2 cm depth. Nitrogen band placement method showed significantly higher beet yield of 82.71 and 84.59 t ha^{-1} during first and second years, respectively, with an average yield of 83.65 t ha. The higher beet yield because of banded nitrogen may be due to the fact that it might have adapted the growth behavior and root development indicating more beet yield. EL-Hennawy et al. (1998) observed that increasing nitrogen rate (120 kg N ha^{-1}) increased beet yield. The incorporation of biochar at the rate of 50 t ha^{-1} showed an increase in beet yield. Maximum beet yield (80.97 t ha^{-1}) was produced by 50 t ha^{-1} biochar additions in first year which improved up to 82.83 t ha^{-1} with 50 t ha^{-1} amended biochar in second year and resulted in average yield of 81.90 t ha^{-1}. Biochar application improved soil fertility with enhancing plant growth in addition to root weight and yield indicating higher beet yield. Kurt *et al.* (2012) reported that yield increases after black carbon or biochar additions. The incorporation of banded fertilizer and 50 t ha^{-1} biochar showed maximum beet yield of 83.46 and 84.78 t ha^{-1} during first and second year, respectively. The obtained beet yield of banded nitrogen and biochar application was 84.12 t during both years.

Total biomass yield (t ha^{-1})

Analysis of variance indicated that total biomass yield was significantly affected by sowing depths, nitrogen methods, biochar application and interaction between SD x NM, while interaction between NM x BC, SD x BC and SD x NM x BC was non-significant (Table-4). Comparison of planned mean for total biomass yield among control vs rest was significant during both years ($p<0.01$). Maximum total biomass yield (137.07 t ha^{-1}) was recorded in sugar beet plants sown at 2 cm depth during first year which increased up to 137.48 t ha^{-1} during second year. Mean maximum total biomass yield (137.27 t ha^{-1}) was observed in 2 cm deep plants. The application of banded nitrogen mixed with biochar significantly improved total biomass yield of sugar beet planted at 2 cm depth. It means that more deep plants may have limited N uptake liable to early intensification period resulting low organic matter.

Evans *et al*. (2009) reported that sugar beet planted at 2.5 cm depth treated with band method of fertilization is a most appropriate method for sugar beet production. Band placement method showed significantly higher total biomass yield (142.67 and 145.87 t ha^{-1}) during first year and second year, respectively. Banded nitrogen might have modified the growth behavior indicating more total biomass yield. Singh *et al.* (2010) reported that faction of nitrogen could amplify crop yield along with nitrogen use efficiency. Average higher total biomass yield (144.27 t ha^{-1}) was recorded in plants banded with nitrogen. The incorporation of biochar at the rate of 50 t ha^{-1} made significant difference to total biomass yield resultant maximum yield of 141.47 t ha^{-1} during first year which increased up to 146.39 t ha^{-1} with 50 t ha^{-1} applied biochar during second year. The average total biomass yield (143.93 t ha^{-1}) was produced by 50 t ha^{-1} biochar assimilation. High total biomass yield may be due to high rate of biochar integration by individual plant performance resulted higher biomass yield. Kurt *et al*.

(2012) stated that yield increases after biochar additions as suggestions of the many evaluations. The combination of banded nitrogen and biochar applied at 50 t ha^{-1} showed maximum total biomass yield of 143.07 and 148.15 t ha^{-1} during first and second year, respectively. The average highest total biomass yield of this intermingle was about 145.61 t ha^{-1}.

Sugar yield (t ha^{-1})

Placement of nitrogen incorporated with biochar significantly enhanced sugar yield. Planned mean comparison for sugar yield between control vs rest was significant ($p<0.01$). Mean maximum sugar yield (12.18 t) was observed in plants sown 2 cm deep (Table-5). Sugar beet plants at 2 cm depth showed maximum sugar yield (12.07 t) during first year which enhanced up to 12.28 t ha^{-1} during second year. Placement of bio-fertilization at 2 cm depth provided the best overall nitrogen availability during progressive episode. Evans *et al.* (2009) reported that sugar beet planted at 2.5 cm depth treated with band method of fertilization is a most favorable technique. Band placement method of nitrogen showed considerably higher sugar yield (13.17 and 13.43 t) during first year and second year, respectively. Higher sugar yield under band placement method was associated with higher beet number, more beet root weight and higher beet yield. Shalaby *et al*. (2003) observed that high value rate of nitrogen could significantly increase sugar yields ha^{-1}. Average higher sugar yield (13.30 t) was recorded in plants banded with nitrogen. Maximum sugar yield (12.66 t) was produced by 50 t ha^{-1} biochar accumulation during first year which increased up to 13.13 t with 50 t ha^{-1} amended biochar during second year. Higher sugar yield appears to crop up with the advanced incorporation of biochar. McHenry (2011) provided quantitative evaluation of safe biochar application rates and consistency of applying biochar to soils in relation to sugar beet yields. The average sugar yield (12.89 t) was produced by 50 t ha^{-1} biochar integration. The combined application of banded nitrogen and biochar amendment (50 t ha^{-1}) showed maximum sugar yield of 13.42 and 13.61 t ha^{-1} during first and second year, respectively. The average higher sugar yield of 13.51 t ha^{-1} was found in this combination during both years.

CONCLUSION

It is concluded from the results that sugar beet planted at 2 cm depth fertilized with banded nitrogen and biochar assimilation showed maximum sugar yield and represented as the best combination for sustainable production in sugar beet.

Table-1. Weeds m^{-2} of sugar beet as affected by sowing depths, nitrogen placement methods and biochar application

Sowing depth(cm)	Year11-12	Year 12-13	Mean
SD 1	5.43	5.45	5.44
SD 2	5.43	5.46	5.44
SD 3	5.42	5.41	5.41
SD 4	5.49	5.43	5.46
LSD (0.05)	Ns	Ns	Ns
Treatments N 140kgha^{-1} Methods, Biochar(tha^{-1})			
Control	5.19	5.07	5.13
Broadcast + 25 BC	5.46	5.43	5.44
Broadcast + 50 BC	5.44	5.49	5.46
Band + 25 BC	5.49	5.47	5.48
Band + 50 BC	5.50	5.56	5.53
LSD (0.05)	Ns	Ns	Ns
Nitrogen methods (NM)(140kgha^{-1})			
Broadcast	5.45	5.46	5.45
Band placement	5.49	5.51	5.50
Significance	Ns	Ns	Ns
Biochar (t/ha)			
25	5.47	5.45	5.46
50	5.47	5.52	5.50
Significance	Ns	Ns	Ns
Treatments			
Control	5.19	5.07	5.13
Rest	5.47	5.48	5.48
Significance	**	**	**
Interaction	P value	P value	P value
NM x BC	Ns	Ns	Ns
SD x NM	Ns	Ns	Ns
SD x BC	Ns	Ns	Ns
SD x NM x BC	Ns	Ns	Ns

Means for each categories followed by different small letters are significantly different from each other at 5% level of probability ($P \leq 0.05$), ns = ($P \geq 0.05$).

Table-2. Foliage Yield (t ha^{-1}) of sugar beet as affected by sowing depths, nitrogen placement methods and biochar application

Sowing depth (cm)	Year 11-12	Year 12-13	Mean
SD 1	62.62	63.76	63.19b
SD 2	65.48	71.71	68.59a
SD 3	60.61	62.59	61.60b
SD 4	55.55	57.00	56.27c
LSD (0.05)	8.53	3.83	2.54
Treatments N 140kgha^{-1} Methods, Biochar(tha^{-1})			
Control	23.16	16.85	20.00e
Broadcast + 25 BC	61.78	61.49	61.64d
Broadcast + 50 BC	63.64	67.95	65.80c
Band + 25 BC	68.57	71.46	70.01b
Band + 50 BC	69.23	77.61	73.42a
LSD (0.05)	6.50	4.93	2.00
Nitrogen methods (NM) (140kgha^{-1})			
Broadcast	62.71	64.72	63.72b
Band placement	68.90	74.53	71.72a
Significance	**	**	**
Biochar (t/ha)			
25	65.18	66.47	65.82b
50	66.43	72.78	69.61a
Significance	ns	**	**
Treatments			
Control	23.16	16.85	20.00b
Rest	65.81	69.63	67.72a
Significance	**	**	**
Interaction	P value	P value	P value
NM x BC	Ns	Ns	Ns
SD x NM	Ns	*	**
SD x BC	Ns	Ns	*
SD x NM x BC	Ns	Ns	Ns

Means for each categories followed by different small letters are significantly different from each other at 5% level of probability ($P \leq 0.05$), ns = ($P \geq 0.05$).

Table-3. Beet yield (t ha^{-1}) as affected by sowing depths, nitrogen placement methods and biochar application

Sowing depth (cm)	Year 11-12	Year 12-13	Mean
SD 1	76.54	76.86	76.70b
SD 2	79.42	80.08	79.75a
SD 3	72.47	74.58	73.52c
SD 4	71.83	72.14	71.99d
LSD (0.05)	2.83	4.94	1.55
Treatments N 140kgha^{-1} Methods, Biochar(tha^{-1})			
Control	33.03	28.79	30.91d
Broadcast + 25 BC	77.37	77.18	77.27c
Broadcast + 50 BC	78.48	80.87	79.67b
Band + 25 BC	81.97	84.40	83.18a
Band + 50 BC	83.46	84.78	84.12a
LSD (0.05)	2.90	4.80	1.38
Nitrogen methods (NM) (140kgha^{-1})			
Broadcast	77.92	79.02	78.47b
Band placement	82.71	84.59	83.65a
Significance	**	**	**
Biochar (t/ha)			
25	79.67	80.79	80.23b
50	80.97	82.83	81.90a
Significance	**	*	**
Treatments			
Control	33.03	28.79	30.91b
Rest	80.32	81.81	81.06a
Significance	**	**	**
Interaction	P value	P value	P value
NM x BC	Ns	Ns	Ns
SD x NM	Ns	**	**
SD x BC	Ns	Ns	Ns
SD x NM x BC	Ns	Ns	*

Means for each categories followed by different small letters are significantly different from each other at 5% level of probability ($P \leq 0.05$), ns = ($P \geq 0.05$).

Table-4. Total biomass yield (t ha^{-1}) of sugar beet as affected by sowing depths, nitrogen placement methods and biochar application.

Sowing depth (cm)	Year 11-12	Year 12-13	Mean
SD 1	131.66	135.20	133.43b
SD 2	137.07	137.48	137.27a
SD 3	130.66	133.67	132.17bc
SD 4	128.63	129.30	128.97c
LSD (0.05)	10.39	7.84	3.54
N Methods & Biochar (BC) application			
Control	61.57	59.14	60.35d
Broadcast + 25 BC	138.03	136.66	137.35c
Broadcast + 50 BC	139.87	144.63	142.25b
Band + 25 BC	142.28	143.60	142.94b
Band + 50 BC	143.07	148.15	145.61a
LSD (0.05)	6.58	6.36	2.25
Nitrogen methods (NM) (140kgha^{-1})			
Broadcast	138.94	140.65	139.80b
Band placement	142.67	145.87	144.27a
Significance	**	**	**
Biochar (t ha^{-1})			
25	140.16	140.13	140.15b
50	141.47	146.39	143.93a
Significance	Ns	**	**
Treatments			
Control	61.57	59.14	60.35b
Rest	140.81	143.26	142.04a
Significance	**	**	**
Interaction	P value	P value	P value
NM x BC	0.65	0.13	0.17
SD x NM	0.97	0.00	0.00
SD x BC	0.41	0.64	0.34
SD x NM x BC	0.80	0.23	0.63

Means for each categories followed by different small letters are significantly different from each other at 5% level of probability ($P \leq 0.05$), ns = ($P \geq 0.05$).

Table-5. Sugar yield (t ha^{-1}) of sugar beet as affected by sowing depths, nitrogen placement methods and biochar application.

Sowing depth (cm)	Year 11-12	Year 12-13	Mean
SD 1	11.93	12.16	12.05a
SD 2	12.07	12.28	12.18a
SD 3	11.42	11.62	11.52b
SD 4	11.05	11.09	11.07c
LSD (0.05)	0.75	0.77	0.29
N Methods & Biochar (BC) application			
Control	4.68	4.17	4.42e
Broadcast + 25 BC	11.70	11.46	11.58d
Broadcast + 50 BC	11.90	12.65	12.27c
Band + 25 BC	12.93	13.25	13.09b
Band + 50 BC	13.42	13.61	13.51a
LSD (0.05)	0.77	1.05	0.32
Nitrogen methods (NM) (140kgha^{-1})			
Broadcast	11.79	12.05	11.92
Band placement	13.17	13.43	13.30
Significance	**	**	**
Biochar (t ha^{-1})			
25	12.31	12.35	12.33
50	12.66	13.13	12.89
Significance	**	**	**
Treatments			
Control	4.68	4.17	4.42
Rest	12.48	12.74	12.61
Significance	**	**	**
Interaction	P value	P value	P value
NM x BC	0.29	0.03	0.24
SD x NM	0.37	0.60	0.03
SD x BC	0.41	0.44	0.02
SD x NM x BC	0.57	0.34	0.07

Means for each categories followed by different small letters are significantly different from each other at 5% level of probability ($P \le 0.05$), ns = ($P \ge 0.05$)

REFERENCES CITED

Abdou, M.A. 2000. Effect of planting dates, plant population and nitrogen fertilization on sugar beet productivity under newly reclaimed sandy soils. Ph. D. Thesis, Fac. of Agric., Mansoura Univ.

Abo-Salama, A.M. and S.I. EL-Sayiad. 2000. Studies on some sugar beet cultivars under Middle Egypt conditions: Assiut J. of Agric. Sci., 31(1): 137-159.

Amaducci, M., T.L. Barbanti and G. Venturi. 2010. Comparing application methods for N-fertilizer in the sugar beet crop. Italian J. Agron. 1(1):51-61.

Azab, M.A., M.A. EL-Hawary, M.A. Farag and M.S. Ali. 2000. Effect of soil and foliar nitrogen fertilization on sugar beet in newly reclaimed soils. J. Agric. Sci. Mansoura Univ. 25(11): 6681-6690.

Baldock, J.A. and R.J. Smernik. 2002. Chemical composition and bioavailability of thermally altered Pinus resinosa (Red pine) wood. Organic Geochemistry, 33: 1093-1109.

Clough, T.J., L.M. Condron, C. Cammann and C. Müller. 2013. A review of biochar and soil nitrogen dynamics. Agron. J. 3: 275-293.

Dean, C.Y., J.A. Smith and R.G. Wilson. 1999. Effect of seed type, planter type and depth of planting on sugar beet emergence. J. Sugarbeet Res. 36(4): 1-9.

EL-Hennawy, H.H., B.S.H. Ramadan and E.A. Mahmoud. 1998. Response of sugar beet to nitrogen fertilization levels and its time of application. J. Agric. Sci. 23(3): 969-978.

Evans, R.G., W.B. Stevens and W.M. Iversen. 2009. Development of strip tillage on sprinkler irrigated sugar beet. Appl. Engg. Agric. 26(1): 59-69.

Glaser, B. and C. Steiner. 2002. Potential of pyrolysed organic matter in soil amelioration. 12th ISCO Conference, Beijing. pp. 421-427.

Gul, B., K.B. Marwat, M. A. Khan and H. Khan. 2014. Impact of tillage, plant population and mulches on phenological characters of maize. Pakistan Journal of Botany 46(2): 549-554.

Kandil, A.A., M.A. Badawi, S.A. El-Moursy and U.M.A. Abdou. 2002. Effect of planting dates, nitrogen levels and bio-fertilization treatments on: II- Yield, yield components and quality of sugar beet (Beta vulgaris, L.). J. Agric. Sci. 27(11): 7257-7266.

Khan, M.A., S. Kakar, K.B. Marwat and I.A. Khan. 2013. Differential response of *Zea mays* L. in relation to weed control and different macronutrient combinations. Sains Malaysiana 42(10): 1405-1411.

Kurt, A.S., B.C. Keri, M.N. Jeffrey, W.A. David, A.I. James, H.P. Collins, A.A. Boateng, I.M. Lima and C.L. Marshall. 2012. Biochar: A synthesis of its agronomic impact beyond carbon sequestration. J. Environ. Qual. 41: 973-989.

McHenry, M.P. 2011. Soil organic carbon, biochar, and applicable research results for increasing farm productivity under Australian agricultural conditions. Commun. Soil Sci. Plant Anal. 42(10): pp.1187-1199.

Ramadan, B.S.H. 2002. Sugar beet yield and quality as affected by nitrogen and potassium fertilization. Pak. Sugar J. 11(1): 8-13.

Richard, S.Q., H.D. Thomas and D.L. Jones. 2012. Biochar application reduces nodulation but increases nitrogenase activity in clover. J. Plant Soil. 10(1): 1411-1414.

Shalaby, M.T., M.B. Doma, F.A.A. EL-Latif and M.E.S. Sohair. 2003. 1-Agricultural, chemical and technological studies on sugar beet. 2-Effect of nitrogen application on yield, chemical constituents and juice quality characteristics of sugar beet. J. Agric. Sci. 28(3): 1853-1864.

Singh, U.A., W.A. Paul, I.B. Jahan, J.A. Sanabria and S.A. Kovach. 2010. Enhanced efficiency fertilizers: 19th World Congress of Soil Science, Soil Solutions for a Changing World, 1–6 August 2010, Brisbane, Australia.

Steel, R.G.D., J.H. Torrie and D.A. Dickey, 1997. Principles and procedures of statistics. A biometrical approach. 3rd (ed). McGraw Hill Companies, Inc. New York, USA.

Stevanato, P., C. Zavalloni, M. Rosa, B. Marco, S. Massimo and J.M. McGrath. 2010. Relationship between subsoil nitrogen availability and sugar beet processing quality. Agron. J. 102(1): 17-22.

Stevens, W.B., R.G. Evans, J.D. Jabro, and W.M. Iversen. 2011. Sugar beet productivity as influenced by fertilizer band depth and nitrogen rate in Strip Tillage. J. Sugar Beet Res. 48(3-4): 137-154.

Sultan, M.S., A.N. Attia, A.M. Salama, A.E. Sharief and E.H. Selim. 1999. Biological and mineral fertilization of sugar beet under weed control: Sugar beet productivity. Proc.1st Intern. Conf. on Sugar and Integrated Industries; Present & Future, 15-18th Feb. 1999, Luxor, Egypt. I: 170-181.

Wilson, R.G. and J.A. Smith. 2002. Crop production with glyphosate tolerant sugar beet. J. Sugar Beet Res. 36(3): pp.96-99.

Zimny, L., R.W. and D. Malak. 2007. The effect of varying organic and nitrogen fertilization on morphological features of sugar beet roots. Fragmenta Agronomica, 24(96): 299-304.