Journal of Natural Resource Conservation and Management
Vol. 1, No. 2, pp 112-118, 2020
doi: 10.51396/ANRCM.1.2.2020.112-118

Impact of planting techniques on the growth and quality performance of maize hybrids in the spring season

Aashish Kumar[1], B.R. Kamboj[2], S.K. Thakral[1] and Kapil Malik[3,*]

[1] Department of Agronomy, CCS Haryana Agricultural University, Hisar-125004, Haryana, India; [2] KrishiVigyan Kendra, Damla, Yamunanagar, CCS Haryana Agricultural University, Hisar-125004, Haryana, India; [3] Soil and Crop Management, ICAR-Central Soil Salinity Research Institute, Karnal-132001, Haryana, India
**Corresponding author E-mail: Kapilmalik017@hau.ac.in*

Received : September 10, 2020
Revised : November 25, 2020
Accepted : November 29, 2020
Published : December 23, 2020

ABSTRACT

A field trial was conducted at Yamunanagar, Haryana, India during the spring season to study the performance of maize hybrids under different planting techniques. The 5 maize hybrids viz; HM-4, HM-9, HM-10, HM-11, and HQPM-5 were tested under three planting techniques: ridge, flat, and furrow methods. The growth parameters like plant-stand per hectare, plant height (cm), and dry matter accumulation (g/plant)were recorded higher under ridge method of planting followed by flat and furrow but had no significant effect on the quality parameters such astryptophan, lysine, protein, zinc, iron and nitrogen content in maize grains. The periodic growth parameters such as plant stand per hectare, plant height, and dry matter accumulation were significantly higher with hybrid HM-10 followed by the rest of maize hybrids whereas, zinc and iron content was not significantly affected in any of the maize hybrids. Tryptophan and lysine content was significantly higher inHQPM-5 hybrid but nitrogen and protein content were more in HM-4 hybrid. In conclusion, the planting method had significant effects on the yield parameters yet quality parameters are less affected by the planting. The varietal genotype has more influence on the performance, productivity, and quality, under different planting techniques.

Keywords: Planting methods, hybrids, dry matter, nitrogen, growth and quality parameters

INTRODUCTION

Maize (*Zea mays* L.) is one of the important cereal crops next to wheat and rice in the world. Globally, maize is referred to as 'Miracle crop' or 'Queen of the Cereals' due to its high productivity potential compared to other Gramineae family members. Maize serves as a basic raw ingredient to thousands of industrially manufactured products viz; alcoholic beverages, pharmaceutical, food sweeteners, cosmetic, textile, gum, and paper industries (Kumar *et al*., 2012). In India, nearly about 28% of maize produced is used for food purposes, 11% used in livestock feed, 12% in the wet milling industry, 48% as poultry feed, and 1% as seed (Anonymous, 2013). Maize cultivation is gaining popularity in the spring season because *Spring* maize usually gives more production as compared to *kharif* crop and it is relatively safe from insect pest attack and it can easily be grown in the areas where adequate irrigation facilities are available but the yield recovery of maize at farmer's field is very low as compared to other maize producing countries such as Italy, U.S.A., Canada, and Egypt, etc., therefore, to boost up the maize production, proper management techniques are essential (Kumar *et al*., 2018).

The major techniques are high-yielding hybrids and proper methods of planting. Maize can be planted in different ways *viz*. ridge planting, furrow planting, flat planting, and broadcasting. Inputs such as water and nutrients are economically utilized if the plants are planted with appropriate planting

techniques (Ali *et al.*, 1998). Agronomical practices and crop varieties possibly affecting the yield, evapotranspiration, and energy balance status (Hussain *et al.*, 2019). The response of maize hybrids to various agro-management practices especially; fertilizers, planting methods, etc. is different. This variable response is mainly due to differences in plant morphology, intraspecific competition in maize plants crop growth rate, crowding stress tolerance of different maize varieties. The total biomass production of maize depends upon the water use and different planting techniques affect the water use efficiency (WUE) of crop and field application efficiency (Hamilton *et al.*, 2015).

The mature maize kernel consists of a small embryo, much large endosperm, pericarp, and tip cap. The endosperm contains the main carbohydrates. In normal maize, essential amino acids like lysine, tryptophan, and threonine are found in reduced quantities. In contrast, QPM (Quality Protein Maize) has a great potential in human nutrition and it is also a good source of protein requirement and it has nearly twice the amount of lysine and tryptophan, which make the protein of QPM equivalent to 90% of milk protein. HQPM hybrids are found to be the best hybrids for the cultivation of high-quality protein therefore comparative study of promising maize hybrids was also essential to screen the most promising hybrids for spring planting. Keeping the above facts in view, the present investigation was undertaken.

MATERIALS AND METHODS

A field investigation was carried out at the village Talakaur, district Yamunanagar under KVK, Damla of Chaudhary Charan Singh Haryana Agricultural University (CSSHAU), Hisar, Haryana during *spring* season of 2015. The experimental site was situated in a semi-arid, sub-tropical region at an elevation of 255m above mean sea level (msl) having 30°07′ North latitude and 77°17′ East longitude. The weather data is presented in Fig. 1 showed that the maximum rainfall was received during 9th standard week and a total of 259 mm rain was received during the crop growing season whereas, the maximum and minimum temperature ranged from 21.1°C to 41.7°C and 9.1°C to 27.4°C respectively. The mean weekly value of relative humidity during morning and evening time ranged from 47.3% to 95.9% and 30.8% to 83%, respectively, during the crop period.In general, weather conditions were favorable for plant growth, and no severe pests and diseases were noticed during the entire period.

To measure the soil physico-chemical properties, samples were drawn randomly from 0-15 cm depth from the five randomly selected spots in the experimental field, and after that a representative sample was prepared by mixing all samples. This composite sample was analyzed to determine the physical and chemical properties of the soil (table 1).

The treatments comprised of 3 different planting techniques viz., ridge, flat, and furrow and 5 maize hybrids *viz.,* HM-4, HM-9, HM-10, HM-11, and HQPM-5. The research trial was performed in a split-plot design (SPD). The methods of planting were kept in the main plot and maize varieties were placed in a subplot with 3 replications. The layout of the field is presented in Fig. 2.

The seedbed in the field was prepared by practicing 4 harrowing's followed by twice cultivator and then planking. The pre-sowing irrigation was given to the desired area of the field to facilitate preparatory tillage and seed germination. Depending upon the treatments, the furrow and ridges were

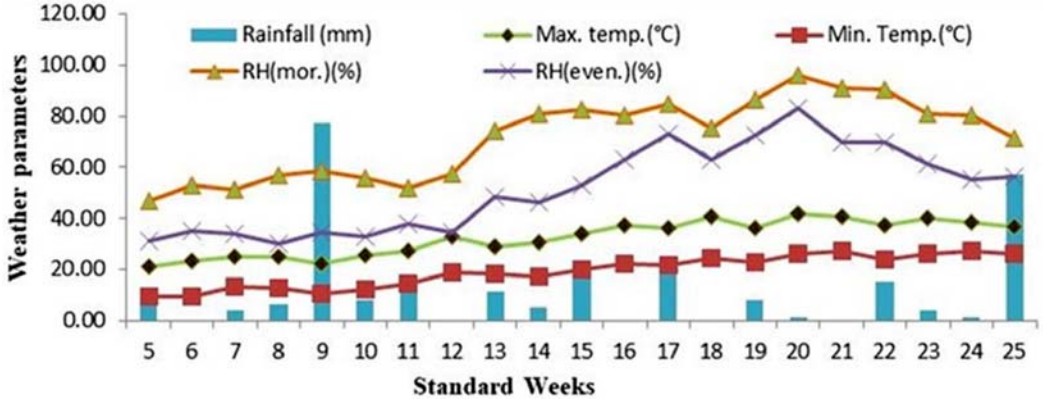

Figure 1. Mean weekly meteorological data during crop growth period

Table 1. Physico-chemical properties of the experimental soil

Soil properties	Value/ characteristic	Method used
Soil texture	Sandy-loam	Hydrometer method (Piper, 1966)
Sand (%)	53	International pipette method (Piper, 1966)
Silt (%)	35	
Clay (%)	12	
Soil pH (1:2 soil: water)	8.5	Glass electrode pH meter (Jackson, 1973)
Electrical conductivity(dSm^{-1})	0.56	Conductivity bridge meter 1:2 soil-water suspension (Richards, 1954)
Available nitrogen (kg ha^{-1})	116	Alkaline Permanganate method (Subbaiah and Asija, 1956)
Available phosphorus (P_2O_5 kg ha^{-1})	14.0	Olsen's method (Olsen *et al.*,1954)
Available potassium (K_2O kg ha^{-1})	365.0	Flame photometer method (Richards, 1954)

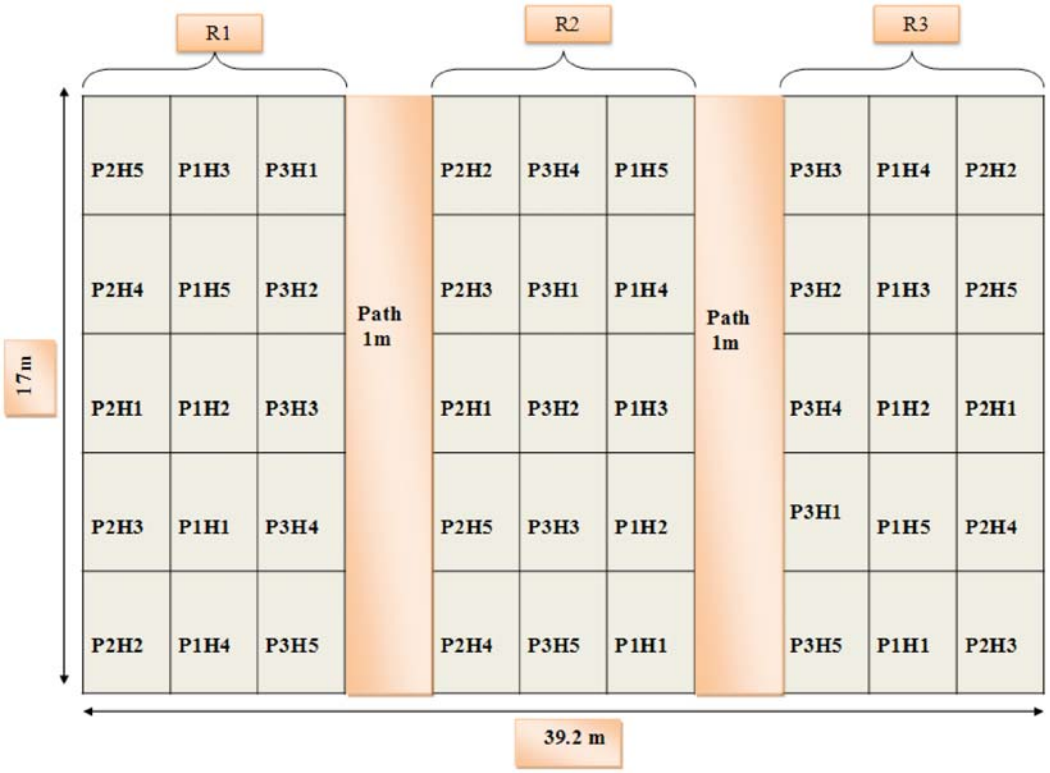

Figure 2. Layout of the experiment. P1 = Flat planting, P2 = Ridge planting, P3 = Furrow planting; H1 =HM-4, H2 =HM-9, H3 =HM-10, H4 =HM-11, H5 =HQPM-5.

made with the assistance of a tractor-drawn ridger for manually dibbling of seed. The maize crop was raised with the help of a recommended package of practices.The growth parameters viz., plant stand ha^{-1}, dry matter accumulation, plant height, phenological stages were recorded from the penultimate rows of each plot. The number of plants per hectare was noted by counting plant numbers per meter (m) row length in each plot and converted to net plot size and finally to thousand plants ha^{-1}. The plant height was measured at different growth stages from the base of the plant to the top leaf (fully opened) (Malik *et al.*, 2019) but after tasselling, plant height was taken from the plant base to the collar of the flag leaf. For dry matter accumulation measurement, 5 plants were selected randomly in each plot and carefully uprooted which were oven-dried at 65±5°C to attained constant weight and further weighed. The phenological readings of maize (50% tasselling and 50% silking) were noted by counting the non-tassel and non-silk bearing and tassel and silk bearing plants whereas, the number of days to maturity was measured by counting the numbers of days (from sowing to maturity) when

mostly cobs husk turns yellow colour followed drying. The nitrogen content in the grain was measured by adopting the Nessler reagent method. Oven-dried grain sample (0.2 g) was digested in di-acid mixture of H_2SO_4:$HClO_4$ (9:1) and after digestion, a known volume of sample was made with the distilled water and filtered through Whatman No. 42 filter paper and used for further analysis. The nitrogen (N) content in the grain was measured by reading the intensity of color on a spectrophotometer at 440 nm wavelength. The protein, lysine, and tryptophan content in maize grains were estimated by Near-Infrared Spectrophotometer (NIRS) NIR analyzer (Infratec™ 1241 grain analyzer) whereas, zinc (Zn) and iron (Fe) content were measured by Atomic Absorption Spectrophotometer (AAS) instrument. In this method, oven-dried sample (0.2 g) of grain was digested in diacid mixture of HNO_3: HClO4 (4:1) and used for further analysis.

RESULTS AND DISCUSSION

Growth parameters

Different planting methods of maize crop influenced the plant height (cm) at all the growth stages at 30 days intervals and found that the plant height significantly increased from 30 days after planting to maturity which is depicted in Fig. 3A. The results showed that the maximum plant height of maize was achieved in the ridge planting method followed by the flat and furrow method of planting. This was due to the presence of loose fertile soil having more aeration and moisture availability, along with better uptake of nutrients which might provide a better environment to maize crop resulting in improved plant height. These results conformed with Singh *et al.* (2011).

The plant height (cm) of maize hybrids was measured at 30 days interval. The hybrid (HM-11) attained more plant height at all stages which was superior to the rest of the maize hybrids presented in Fig. 3B. This could be due to varietal variation of crop and also environmental conditions that prevailed during stem elongation and growth of plants (Gaile, 2012 and Azadbakhat *et al.,* 2012). The plant stand per hectare was recorded highest under the ridge method followed by flat and furrow methods of planting (Table 2). The higher number of plant population in ridge planting techniques may be attributed to the fine-tilth and better aeration on ridges which helped in deeper root penetration (Singh *et al.*, 2011; Painyuli *et al.*, 2013; Kumar *et al.*, 2014) Nevertheless, the plant population was not influenced significantly in relation to maize hybrids but numerically maximum plant stand (79824) were recorded with hybrid HM-10 followed by HM-11, HQPM-5, HM-4 and HM-9 (Khan *et al.*, 2012).

The study results also revealed that the phenological stages of maize crop were also significantly affected by different treatments. The number of days taken to attain the phonological stages namely 50 % tasseling, 50 % silking and the maturity were less on ridge planting techniques than flat and furrow methods of planting. It was because of more nutrients uptake on ridges and further

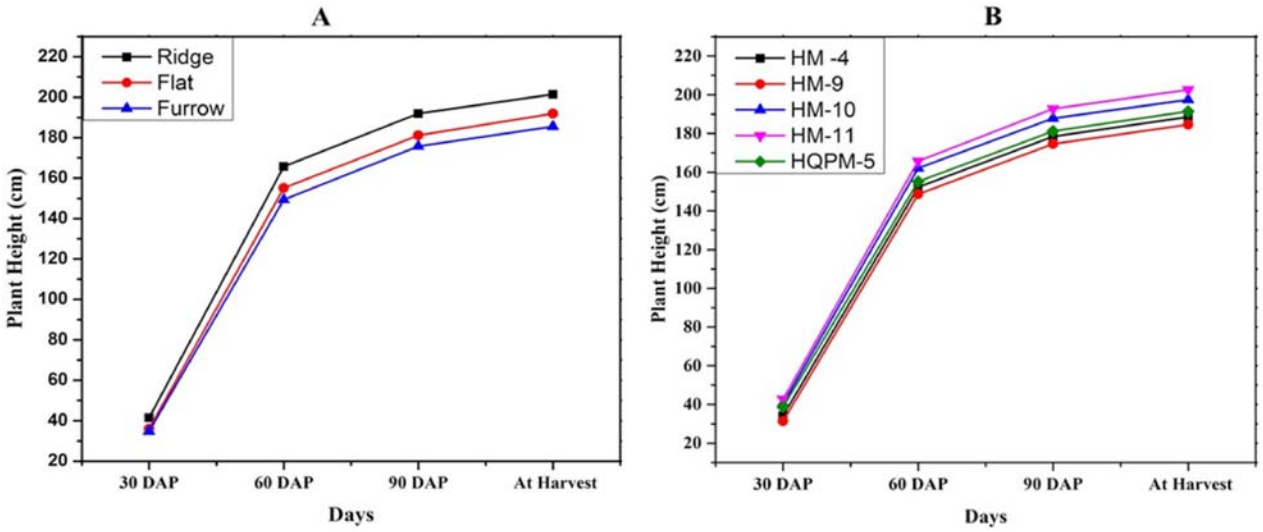

Figure 3. Plant Height (cm) of maize crop affected by different treatments viz.: (A) Planting methods, (B) Maize Hybrids

Table 2. Growth parameters of maize as affected by different planting methods and hybrid.

Treatments	Plant Stand ha^{-1} (15 DAP)	Days to 50% Tasseling	Days to 50% Silking	Days to Maturity
Planting Techniques				
Ridge	82810	58	61	108
Flat	76754	61	63	113
Furrow	74143	62	65	114
SEm±	846	0.5	0.5	1.3
CD (P=0.05)	3306	2	2	4
Hybrids				
HM-4	76811	57	60	107
HM-9	76484	59	61	109
HM-10	79824	62	64	115
HM-11	78748	63	65	115
HQPM-5	77644	61	63	113
SEm±	1272	1	1	1.4
CD (P=0.05)	NS	3	3	4

facilitate better root growth which known to stimulate more flowering in maize (Rasheed *et al.*, 2003; Mehta *et al.*, 2011) however, among hybrids of maize, HM-4 and HM-9 hybrids took lower number of days to attain 50 % tasseling, 50 % silking and maturity stage while HQPM-5, HM-10 and HM-11 hybrids required more days to reach different phonological stages because of their different maturity timing (Kagasago, 2006; Tsimba *et al.*, 2013).

The accumulation of dry matter is a good index, to express the photosynthetic efficiency of the plants, noticeably higher total dry matter including leaves, cob and stem was recorded with ridge planting method which could be due to higher plant height and functional leaves under ridge planting techniques. These results are also in agreement with Husain *et al.* (2010) and Gul *et al.* (2015). The HM-10 hybrid significantly differed with respect to dry matter accumulation (g plant^{-1}) at different growth stages and at harvest stage also (Dawadi and Sah, 2012).

Quality parameters

The lysine, tryptophan, protein, nitrogen, zinc, and iron content in maize seeds are the important quality factors that are to be considered while assessing the effect of different treatments and competitive ability of the crop with nutrients. The effect of planting techniques on different quality parameters was found to be non-significant in the present study. However, the ridge method of planting had maximum values of quality parameters as compared to flat and furrow methods. These

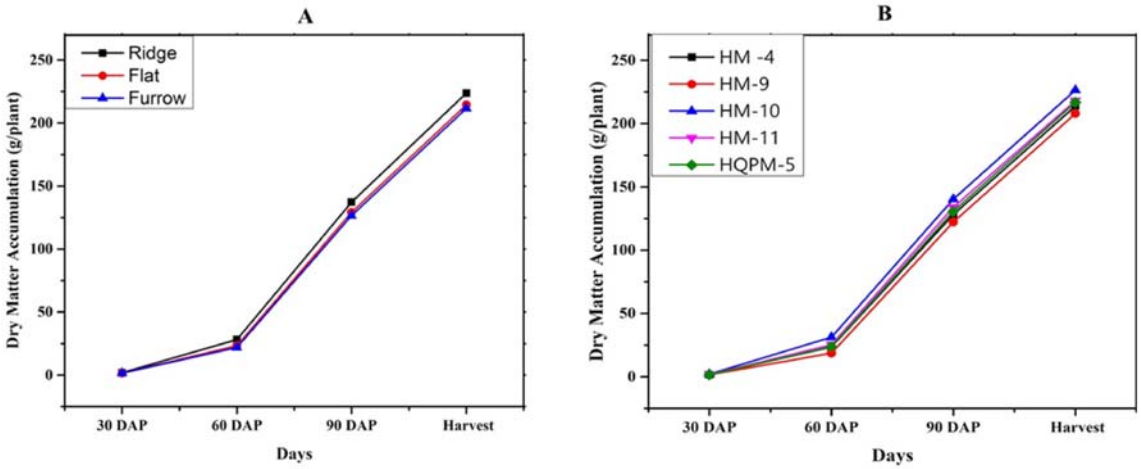

Figure 4. Dry matter accumulations (g plant^{-1}) of maize crop affected by different treatments viz.: (A) Planting methods, (B) Maize Hybrids

Table 3. Quality parameters of maize as affected by different planting methods and hybrids

Treatments	Tryptophan content (%)	Lysine content (%)	Protein content (%)	Nitrogen content (%)	Zinc content (μg g^{-1})	Iron content (μg g^{-1})
Planting methods						
Ridge	0.47	1.31	10.64	1.48	22.21	29.43
Flat	0.46	1.28	10.62	1.47	21.41	28.57
Furrow	0.45	1.26	10.59	1.45	20.62	27.5
SEm±	0.01	0.02	0.02	0.01	0.57	0.54
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Hybrids						
HM -4	0.33	0.92	10.85	1.46	20.28	28.61
HM-9	0.39	1.1	10.59	1.36	21.53	28.39
HM-10	0.41	1.12	10.66	1.37	22.31	27.64
HM-11	0.42	1.13	10.64	1.4	22.09	29.33
HQPM-5	0.73	2.13	10.23	1.38	20.87	28.5
SEm±	0.01	0.02	0.08	0.01	0.71	0.76
CD (P=0.05)	0.03	0.07	0.24	0.03	NS	NS

differences were could be due to the vigorous growth, bolder size of grains, and higher nutrient uptake by the maize crop. Similar results were also obtained by Rehman *et al*. (2011).

Amongst different hybrids, HQPM-5 hybrid contained significantly higher lysine and tryptophan content while protein and nitrogen content were found to be more in HM-4 hybrid. Zinc and iron content was almost same in all the hybrids. These differences in maize hybrids with respect to tryptophan, lysine, protein and nitrogen content were ascribed to variation in their genetic makeup (Nagy, 2009).

CONCLUSION

Overall, the study revealed that in spring season, ridge planted maize crop has significantly higher growth and better growth parameters. However, quality parameters of maize grain do not get influenced by planting methods. Among the compared hybrids, the HM-10 hybrid had significantly higher growth parameters, but the lysine and tryptophan content were considerably higher in hybrid HQPM-5, and protein and nitrogen content were higher in hybrid HM-4.

REFERENCES

Ali, M., Khalil, S.K., Ayaz, S. and Marwat M.I. (1998). Phenological stages, flag leaf area, plant height and leaves per plant of corn as influenced byphosphorus levels and plantspacing. *Sarhad Journal of Agriculture, 14*, 515-522.

Anonymous, (2013). Annual *Kharif-Maize Progress Report 2007*, Directorate of Maize Research, IARI, New Delhi.

Azadbakht, A., Azadbakht, G., Nasrollahi, H. and Bitarafan, Z. (2012). Evaluation of different planting dates effect on three maize hybrids in koohdasht region of Iran. *International Journal of Science and Advanced Technology, 2*(3), 34-38.

Dawadi, D.R., and Sah, S.K. (2012) Growth and yield of hybrid maize (*Zea mays* L.) in relation to planting density and nitrogen levels during winter season in Nepal. *Tropical Agricultural Research, 23*(3), 218 – 227.

Gaile, Z. (2012). Maize (*Zea mays* L.) response to sowing timing under agro-climatic conditions of Latvia. *Zemdirbyste Agriculture*, *99*(1), 31-40.

Gul, S., Khan, M.H., Khanday, B.A. and Nabi, S. (2015). Effect of sowing methods and NPK levels on growth and yield of rainfed maize. *Hindawi Publishing Corporation Scientifica, 7*, 1-6.

Hamilton, S. K., Hussain, M. Z., Bhardwaj, A. K., Basso, B., and Robertson, G. P. (2015). Comparative water use by maize, perennial crops, restored prairie, and poplar trees in the US Midwest. *Environmental Research Letters*, *10*(6), 064015.

Husain, M., Farooq, M., Jabran, K. and Wahid, A. (2010). Foliar application of glycinebetaine and salicylic acid improves growth, yield and water productivity of hybrid sunflower planted by different sowing methods. *Journal of Agronomy and Crop Science, 196*, 136-145.

Hussain, M.Z., Hamilton, S.K., Bhardwaj, A.K., Basso, B., Thelen, K.D., and Robertson, G.P. (2019). Evapotranspiration and water use efficiency of continuous maize and maize and soybean in rotation

in the upper Midwest US. *Agricultural water management*, *221*, 92-98.

Jackson, M.L. (1973). *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi.

Kgasago, H. (2006). Effect of planting dates and densities on yield and yield components of short and ultra-short growth period of maize *(Zea mays* L.). *Ph.d thesis*, *University of Pretoria*, pp. 57-59.

Khan, N., W. Khan, N. and Khan, I. A. (2012). Integration of nitrogen fertilizer and herbicides for Efficient weed management in maize crop. *Sarhad Journal of Agriculture*, *28*, 457–463.

Kumar, A., Kamboj, B.R. and Thakral, S.K. (2018). Comparative analysis of maize (Zea mays) hybrids under different methods of planting in spring season. *Indian Journal of Agricultural Sciences*, *88*(6), 907-909.

Kumar, B., Chikkappa, G.K., Jat, S.L., Parihar, C.M., Yathish, K.R., Singh, V., Hooda, K.S., Dass, A.K., Mukri, G., Sekhar, J.C., Kumar, R. and Kumar, R. (2012). Maize biology: An Introduction, Directorate of Maize Research, Indian Council of Agricultural Research (ICAR), *Technical Bullettin, 2*, 32-36.

Kumar, S., Shivani and Kumar, S. (2014). Performance of transplanted maize under varying age of seedling and method of nursery raising in the midlands of eastern region. *Indian Journal of Agricultural Sciences*, *84*, 877-882.

Malik, K., Mehta, A.K., Thakral, S.K., and Abhilash. (2019). Crop geometry and nitrogen management impacts on cotton cultivar H-1098 (i) productivity. *Indian Journal of Agricultural Sciences*, *89*(11), 61-65.

Mehta, S., Bedi. S. and Vashist, K.K., (2011). Performance of winter maize hybrid to planting methods and nitrogen levels. *Indian Journal of Agricultural Sciences, 8*, 50-54.

Nagy, J. (2009). Effect of sowing date on the yield and quality of maize hybrids with different growing seasons. *Acta Agronomica Hungarica*, *57*, 389-399.

Olsen, S.R., Cole, V.C., Watanabe, F.S. and Dean, L.A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *United States Department of Agriculture Circle, 939*, 621-628.

Painyuli, A., Pal, M.S., Bhatnagar, A. and Bisht, A.S. (2013). Effect of planting techniques an irrigation scheduling on productivity and water use efficiency of sweet corn. *Indian Journal of Agronomy, 58*, 344-348.

Piper, C.S. (1966). *Soil and plant analysis*. Hans Publisher, Bombay.

Rasheed, M., Mahmood, T. and Nazir, M.S. (2003). Response of hybrid maize to different planting methods and nutrient management. *Pakistan Journal of Agricultural Sciences*, *40*, 39-42.

Rehman, A., Saleem, F., M., Safdar, E., M., Husain, S. and Akhtar, N. (2011). Grain quality, nutrient use efficiency and bioeconomics of maize under different sowing methods and NPK levels. *Chilen Journal of Agricultural Research*, *7*, 586-593.

Richards, L.A. (1954). Diagnosis and improvement of saline and alkaline soils. USDA Hand Book No. *60*, Washington, D.C.

Singh, V., Ram, S., Bhatnagar, A. and Savita, S. (2011). Effect of tillage methods on soil properties and productivity of quality protein maize-wheat system. *Indian Journal of Agronomy, 56*, 83-87.

Subbiah, B.V. and Asija, G.L. (1956). A rapid procedure for estimation of available nitrogen in soils. *Current Science, 25*, 259-260.

Tsimba, R., Edmeades, G.O., Millner, J.P., and Kemp, P.D. (2013). The effect of planting date on maize: Phenology, thermal time durations and growth rates in a cool temperate climate. *Field Crops Research*, *150*, 145–155.