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A review on crop establishment methods on weed, yield and quality of maize crop

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Abstract
To sustain productivity and to increase the profit margin of farmers in maize crop, the major emphasis has been on alternative resource conservation technologies. In order to ameliorate the ill effect of traditional cropping system, efforts have been made to develop several resource conservation technologies. A shift in maize production system from rice is testimony of the resource conservation technologies. In view of conservation of natural resources, more emphasis is needed to accelerate the adoption of cost effective and environment-friendly crop management practices such as ridge and furrow, conventional flat bed, raised-bed planting hence, an attempt has been made in this chapter to review crop establishment methods *viz*., ridge and furrow, conventional flat bed, raised-bed planting. These are recent improved crop establishment techniques that can be used under specific agro-ecological conditions for enhancing yield and resource conservation.

Keywords: Establishment, methods, maize, crop

Introduction
Maize (*Zea mays* L.) is the world's leading crop and it is one of the most versatile emerging crops having wider adaptability. Maize is known as queen of cereals because of its highest genetic yield potential among food grain. Maize is the only cereal food crop that can be grown in diverse seasons and ecologies. Apart from this, maize is an important industrial raw material and provides large opportunity for value addition. It occupies an area of 9.25 m ha with 25.2 MT productions (IIMR Annual report 2016-17) [2]. Maize is a key source of food and livelihood for millions of people in many countries of the world. It is an important source of many industrial products such as corn sugar, corn oil, corn flour, starch, syrup, brewer's grit and alcohol. The rapid increase demand in industrial use of maize as bio-fuel production is likely to create an additional demand for maize in the coming decades. With the increase in industrial requirements and value-added foods for a growing economy and population, maize would continue to hold its share as a significant crop (Anonymous, 2013) [2].

Meeting ever increasing maize demand in a sustainable way with shrinking natural resources is a great challenge. It can be grown successfully in variety of soils by adopting suitable crop establishment method. To achieve higher productivity, improving resource use-efficiency, better crop establishment and management of pests is the key factor. New production technologies offer great promise for increasing productivity to meet the growing demands of consumers and have favourable impacts on physical and chemical properties of soil. FIRBS and ridge bed planting system have also been reported very beneficial for improving soil environment for better plant and growth development with minimum requirement of irrigation water (Singh *et al.*, 2007 and Basavanneppa *et al.*, 2017) [15, 3]. Sub-soiling is a new introduced intervention to break down the hard pan for improving field drainage and provides better soil tilth. Conserve natural resources through conservation tillage like zero till and raised-beds planting resulted in significantly positive impact on crop yield, WUE, soil health and quality and provides the best opportunity to halt degradation and for restoring and improving soil productivity (Chauhan *et al.*, 2006 and Anonymous, 2013) [2, 4]. Using raised bed planting technology, 20-30% irrigation water can be saved with higher productivity. Moreover, under temporary excess soil moisture/water logging due to heavy rains, the furrows will act as drainage channels and crop can be saved from excess soil moisture stress. For realizing the full potential of the bed planting technology, permanent beds are advisable wherein sowing can be done in a single pass without any preparatory tillage.

Permanent beds are more beneficial under excess soil moisture situations as the infiltration rate is much higher and crop can be saved from the temporary water logging injury (Videnovic *et al.*, 2011 and Lakshmi and Luther, 2017) [19, 10].

Effect of crop establishment methods on weed

Raised beds planted maize recorded lower weed population, but did not show significant variation as compared with sowing on flat bed in the conventionally-tilled plots (Chauhan *et al.*, 2006) [4]. The flat bed method of planting resulted in 14.17% yield improvement over furrow method of planting with 120:60:45 N: P_2O_5: K_2O kg ha^{-1}. Growing maize on raised beds made either at sowing itself or afterwards avoids the adverse effects of short-term water logging during heavy rains and results in more efficient use of irrigation water and nutrients and resulted higher maize yield (Singh *et al.*, 2007) [15]. Singh *et al.* (2007) [15] an experiment was conducted during rainy season at IARI, New Delhi in sandy loam soil with pH *7.7*, 0.38% organic C, 158 kg N, 10.2 kg P, and 161 kg K ha^{-1}. Stale seed-bed practice resulted in the lowest weed and their dry weight over flat bed or raised beds. Conventional tillage on flat bed or raised beds resulted in intermediate and similar weeds growth. Stale seed-bed recorded 13.7% higher yield while the increase under bed planting systems was 6.3-7.5%. Chopra and Angiras (2008) [5] found that significantly lowest density and biomass of total weeds in maize were recorded in raised seed-bed which was statistically at par with conventional tillage under the silty clay-loam soil of Himachal Pradesh. Whereas, the highest weed control efficiency (WCE) was also recorded under the raised seed-bed in comparison to conventional and zero tillage. Abdullah *et al.* (2008) [1] conducted experiment at Peshawar, Pakistan during summer season was recorded significantly highest density and dry weight of weeds in broadcast sowing maize, while minimum density and dry weight of weeds was noted in ridge planting, however it was statistically similar with flat sowing. Under bed planting method soil microbial biomass carbon (13%) was significantly higher than the conventional tillage (Singh *et al.*, 2009) [14].

Effect of crop establishment on crop growth and yield

Jat *et al.* (2005) [8] opined that highest maize yield (5.66 t ha^{-1}) under raised bed system followed by no-till system (4.75 t ha^{-1}) and the lowest yield (4.39 t ha^{-1}) were obtained in conventional tillage system on sandy loam soils of Modipuram. Chopra and Angiras (2008) [5] found that raised seed-bed and conventional tillage being statistically at par with each other, produced significantly higher values of yield-contributing characters (Number of cobs $plant^{-1}$ and 1000 grain weight), grain and stover yield of maize under the silty clay-loam soil of Himachal Pradesh. Srividya (2010) [18] conducted an experiment at Agricultural College Farm, Bapatla and concluded that days to 50% tasseling significantly differed due to tillage methods. In general number of days to 50% tasseling and silking was less under conventional tillage system compared across zero tillage. Singh *et al.* (2011) [16] reported that maximum grain yield of maize was obtained in RFB (raised fresh bed), followed by CT (conventional flatbed) and then ZT (zero tillage without crop residue). RFB being in significant increase in grain yield by 20.8 (t ha^{-1}) and 19.6% (*kharif*), and 22.5 and 15.3% (*rabi*), respectively, over the ZT. Singh *et al.* (2011) [16] from Pantnagar studied the effect of tillage methods on productivity of maize and reported that raised fresh beds recorded significantly highest number of cobs/ha and grain yield of maize followed by conventional tillage practice. Similarly, Videnovic *et al.* (2011) [19] reported that highest average yield was observed with conventional tillage 10.61 t ha^{-1} (100.00%), while the yield was lower with reduced tillage 8.99 t ha^{-1} (84.37%) and no-tillage 6.86 t ha^{-1} (64.65%). Durga *et al.* (2012) [9] experiment was conducted during early *rabi* season at Hyderabad to study the influence of planting methods, spacing and fertilizer doses on sweet corn cv. Madhuri. He reported that flatbed method of sowing resulted higher crop growth and yield attributes and 14.17% yield improvement over furrow method of maize sowing. Flat beds not only increased the yield attributes and seed yield but also found superior for protein content of maize also (Kanaka *et al.*, 2012) [9]. Ramesh *et al.* (2014) [12] reported from Palampur that yield attributes and Stover yield were not significantly influenced by different tillage practices. Ehsanullah *et al.* (2015) [6] study was conducted at Faisalabad, Pakistan. He reported that ridge sowing under deep tillage resulted in significantly highest grains and grain weight per cob, 1000-grain weight, grain and biological yield as well as maximum harvest index and net return over flat sowing and it were statistically at par with bed sowing. In view of the increasing production costs and environmental degradation problems with conventional practices, resource conservation technology like bed planting systems with suitable weed management practices are being advocated for improving resource-use efficiency and achieving sustainable productivity. Basavanneppa *et al.* (2017) [3] conducted an experiment at Agricultural Research Station, Siruguppa, Karnataka, India in deep black soil reported that among the different practices, the higher maize and chickpea grain yield of 6434 kg ha^{-1} was recorded in bed planting in tillage practices as compared to conventional tillage grain yield 6343 kg ha^{-1}.

Effect of crop establishment on quality

Sinha *et al.* (2005) [17] opined that amongst chemical weeding, pre emergence application of atrazine + PoE 2, 4-D performed best with respect to nutrient uptake by maize. Also, Malviya and Singh (2007) [15] from Faizabad (Uttar Pradesh) reported that the highest N uptake by grain and stover was recorded under the weed free treatment and it was significantly higher than rest of the treatments followed by two hand weeding's at 20 and 40 DAS which was statistically at par to the application of alachlor at 2.0 kg ha^{-1}+ 1 hand weeding at 30 DAS in respect of N uptake by grain and stover. Jain *et al.* (2007) revealed in his studies that there were no significantly difference of N, P and K uptake in crops and weeds due to different tillage system. Likewise, Chopra and Angiras (2008) [5] from Palampur (Himachal Pradesh) reported that conventional tillage and raised seed-bed reduced the N, P and K depletion by weeds 13.5 to 30.3, 15.7 to 30.5, and 11.3 to 29.5% respectively and increased the N, P and K uptake by the crop by 16.1 to 18.1, 25.0 to 36.2 and 16.6 to 20.2%, respectively compared with zero tillage. Sarma and Gautam (2010) [13] reported that significantly higher uptake of nitrogen, phosphorous and potassium were observed under tilled condition in comparison to no-tilled condition which may be attributed to lower grain and stover yield under no-tilled condition. Sarma and Gautam (2010) [13] from Pantnagar concluded that nitrogen uptake was more with conventional

tillage and hand weeding twice followed by paraquat spray at 25 DAS. Basavanneppa *et al.*, (2017) [3] conducted an experiment at Agricultural Research Station, Siruguppa, Karnataka, India in deep black soil reported that the higher uptake by crop of N and K was noticed in bed planting method (178 and 144), and conventional tillage (170 and 141 kg $ha^{-1}year^{-1}$) and were significantly superior to other treatments.

Effect of crop establishment on economics

Chopra and Angiras (2008) [5] from Palampur found that conventional tillage and raised seed-bed methods resulted in higher nitrogen uptake by maize crop compared with zero tillage. They further reported that, atrazine @ 1.5 kg ha^{-1} and acetachlor @ 1.25 kg ha^{-1} significantly increased the grain yield and nitrogen uptake. Singh *et al.* (2011) [16] studied the effect of tillage methods on productivity of maize and revealed that fresh raised beds gave the highest net income and B:C ratio followed by permanent raised beds. Gathala *et al.* (2012) conducted on-farm trials at six upazillas in three different districts of Bangladesh, reported that permanent bed planting recorded highest net returns, overall system productivity and profitability in rice-maize cropping system over fresh beds planting, zero tillage, strip tillage, reduced tillage, and the conventional tillage treatment. Ramesh *et al.* (2014) [12] from Palampur observed the resource conservation in maize-wheat cropping system and reported that manual seed drilling recorded significantly higher net returns and B: C ratio than zero tillage, multi-crop planter and conventional tillage.

Conclusion

On the basis of the lots of investigation it may be concluded that raised bed planting is most effective in minimizing weed population, increase growth, yield attributes, yield and quality of crop than other crop establishment method.

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