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ORIGINAL ARTICLE

Evaluation of Pearl Millet (*Pennisetum glaucum* L.) Performance Under Different Planting Methods at Vindhyan Region of India

Babloo Sharma[1], Reena Kumari[2,*], Pratibha Kumari[3], Santosh K. Meena[4] and R. M. Singh[2]
[1]Department of Soil and Water Conservation, Bidhan Chandra Krishi Vishvavidhalaya, Mohanpur, Nadia, West Bengal- 741252, India
[2]Department of Farm Engineering, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh-221005, India
[3]International Rice Research Institute, Philippines – Cereal Systems Initiative for South Asia (CSISA, India office, Patna, Bihar)
[4]Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh-221005, India
*Corresponding author (E-mail: reenakumari.bhu@gmail.com)

ABSTRACT
Pearl millet (Pennisetum glaucum L.) is in the top four of cereals grown in the tropics for human food. The experiment was evaluated during the 2009 kharif (June to October) season in the Vindhyan Region of part of Uttar Pradesh State in India. The treatment comprised of four planting methods (ridge, bed, seed drill, broadcast). The broadcast method served as the control. The objectives were to investigate the effects of planting methods on plant growth, grain yield and quality and the economics of pearl millet during the raining season. The pearl millet growth as well as grain yield were better with ridge, bed and seed drill than broadcast. The maximum grain yield was obtained with ridge planting method. The three new planting methods (ridge, bed, seed drill) tested here also significantly improved the quality of grain as well as millet stover. The maximum cost: benefit ratio was with ridge planting method, followed by bed planting method and then seed drill planting method. This indicates that improved planting methods improved the economics of millet production in an arid zone of India.
Key Words: *Pearlmillet, Planting Methods, Yield, Quality, Economic*

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INTRODUCTION

India is one of the major millet producing countries in the world. The predominant millet types in India are pearl millet (*Pennisetum glaucum* L), finger millet (*Eleusine coracana*), kodo millet (*Paspalum scrobiculatum*), proso millet (*Panicum miliaceum*), little millet (*Panicum sumatrense*), foxtail millet (*Setaria italica*) and barnyard millet (*Echinochloa* spp.) [1]. Pearl millet accounts for almost half of global millet production [2]. Pearl millet is the most important species of millet both in terms of cropped area and contributions to food security in Africa and Asia [3]. Pearl millet is commonly known in India as *Bajri* or *Bajra*. Global production of pearl millet grain probably exceeds 10 million tonnes a year, to which India contributes nearly half [4]. India is the largest producer of pearl millet in Asia, both in terms of area (about 9 million ha) and grain production (8.3 million tonnes) with a recent 3-year average grain yield of 930 kg ha^{-1} [5]. From the early 1980s, the pearl millet production area in India has declined by 22%, but grain yield has increased significantly over the years, due largely to improved varieties [5]. In India, pearl millet is usually grown as a dryland dual-purpose grain and fodder crop, and it is sometimes irrigated, particularly in the summer when the crop is grown mainly as a forage crop.

Under rainfed conditions, ridges may help with conservation and availability of moisture for a relatively longer time. With high rainfall, the furrows between the ridges may help drained out of excess water from

the crop root zone, improved soil temperature, aeration and nutrient availability and also enhanced the depth of crop root zone [6]. Pearl millet is commonly sown by broadcast, pora (drilling with a single tube behind the plow) and kera (hand sowing behind a plow) in rainfed region of India like as Uttar Pradesh, Rajasthan and Andhra Pradesh, etc [7]. Mishra and Tiwari have reported lower root weight in broadcast method as compared to non-conventional planting methods [8]. Therefore, ridge planting significantly higher productivity as compare to convention method [9, 10]. The objective of the present study was to evaluate new planning methods on plant growth, grain yield quality as well as economics of pearl millet production at Vindhyan region, India

MATERIAL AND METHODS

Description of experiment: The experiment was evaluated at Rajiv Gandhi South Campus, Banaras Hindu University, Brakachha in the district of Mirzapur at Vindhyan region, Uttar Pradesh, India, during the 2009 *kharif* season, which starts in June and ends in October. The climate of Vindhyan region is predominantly dry (sub-tropical to dry). Winter season is short (December to February) but summer is long (March to November). The temperature rises up to 48°C or more during summer and drops to 4°C during winter, with a relative humidity varying from 58 to 79%. The average annual rainfall is 1059 mm. Figure 1 shows the weather for 2009. The texture of soil field was a sandy loam (50.1 % sand, 37.2% silt & 12.7% clay), soil was slightly acidity (5.4 pH) and had a low organic carbon (0.16%). The available soil N, P and K contentrespectively, were 177.7, 9.01 and 113.31 kg ha^{-1}. The SBH-7178 cultivar of Pearlmillet was used for the experiment in a randomized complete block design with three replications. Three new planting methods, which consisted of ridge, bed and seed drill were compared to a conventional planting method (broadcast). Millet was sown at the start of raining season on July, 14th 2009. For ridge planting method, row to row spacing between ridges was maintained at 45 cm and made by a tractor drawn Ridger. For bed treatment method, sowing was done by a tractor drawn bed planter at a row spacing of 30 cm onto a prepared bed. For seed drill treatment method, sowing was done with a tractor drawn seed drill at a15-cm row spacing. Broadcast seeding was done by hand. All treatments were seeded at the same rate (4 kg ha^{-1}). All treatments received a uniform fertilizer application of 7.3 kg N $plot^{-1}$ in the form of urea (46-0-0) and 4.5 Kg P_2O_5 $plot^{-1}$ in the form of diammonium phosphate (18-46-0). Phosphorous was applied once, while N twice, first at half was at planting and second half at booting stage. All cultural practices such as weeding and pesticides application were uniform in all the treatments.

Data collection: The observations on growth parameters (plant biomass and number of tillers) at different stages and yield traits (ear diameter and test weight) were recorded randomly from selected five tagged plant in each plot. Grain and stover yields estimation were done from one meter square area in each plot and converted to per hectare basis. Grain and stover quality were determined by the following methods:

Plant materials (grain and stover) were digested in a mixture of nitric, perchloric and sulphuric acids (HNO_3-$HClO_4$-H_2SO_4) and determinations of nitrogen content was done by the micro-Kjeldahl method [11]. Crude protein (CP) content was calculated [12] as:

$$Crude\ protein\ (\%) = N\ (\%) \times 6.25 \quad ...(1)$$

Grain crude fiber content was determined by treating oil-free sample by sulphuric acid (0.26 N) and potassium hydroxide (0.23 N) solution in refluxing systems, followed by oven drying and muffle furnace incineration [13].

$$Grain\ fiber\ (\%) = \frac{W_2 - W_1}{S} \times 100 \quad ...(2)$$

Where W_2; = dried weight of crucible, asbestos mat + fiber,
W_1 = dried weight of crucible and asbestos mat, and
S = oven-dried sample weight.

Carbohydrate content was evaluated using a color reaction of hydrolysate of starch with phenol-sulfuric acid or perchloric acid-anthrone and absorbency measured at 630 nm [14]. These reactions are conducted after the isolation of starch from plant materials and an enzymatic hydrolysis of starch.

$$Carbohydrate\ content\ (\%) = 25 \times \frac{b}{a} \times w \quad ...(3)$$

Where: a ≡ absorbency of diluted standard.
b ≡ absorbency of diluted sample.
w ≡ weight of sample (g).

A simple economics analysis of different treatments was used. The analysis took into account the cost of inputs and income generated from output (grain and stover yield), which we computed using the market price of pearl millet. Net returns (INR. ha^{-1}). The benefit: cost ratio (B:C ratio) was calculated as follow:

$$Net\ returns\ (INR.\ ha^{-1}) = Gross\ returns - Cost\ of\ cultivation \quad ...(4)$$

$$B : C\ ratio = \frac{Gross\ returns}{Cost\ of\ cultivation} \quad ...(5)$$

Statistical analysis: The statistical analysis of recorded experimental data was analyzed by using analysis of variance technique and estimate critical differences, to assess the significance of treatment means at 5% level of probability [15].

RESULTS AND DISCUSSION

Growth and Yield Parameters: The plant biomass and number of tillers were observed at booting and physiological maturity stages of the crop (Table 1). The booting stage of pearlmillet is comes at 60 DAS whereas physiological maturity stages comes at harvest [16]. The plant wet biomass of pearl millet was influenced significantly by planting methods. The maximum plant wet biomass of 155.98 and 253.27 g $plant^{-1}$ at booting and physiological maturity stages, respectively, was obtained with ridge method. In ridge planting, plant wet biomass was higher 7.1 and 7.0 % as compared to bed planting, as well as, 17.7 and 14.2 % over seeddrill planting at booting and physiological maturity stage, respectively. The minimum wet biomass (126.6 g $plant^{-1}$ at booting and 203.95g $plant^{-1}$ at physiological maturity stage) were observed under broadcast method. Araya and Stroosnijder [17] reported that the tide ridge planting was significantly improved above-ground dry biomass as compared to the control under barley crop, it should be attributed due to the conserved soil water in the early and late stage of the crop.

The number of tillers was recorded 3.47 and 4.04 $plant^{-1}$ at booting and physiological maturity stage, respectively, under ridge planting, which was significantly higher than rest planting methods. The minimum tillers were recorded under broadcast, which was 23.0, 16.0 and 6.4 percent lower than ridge, bed and seed drill planting, respectively at booting stage and 22.4, 14.2 and 7.0 percent than ridge, bed and seed drill planting, respectively at physiological maturity stage. The methods of planting were significantly improved number of tillers in pearlmillet crop, due to providing better surrounding environment for crop growth and development, under ridge planting [18].

The yield of crop is the important factor for selection of planting patterns by the farmers. The yield and its components, except test weight, were significantly affected by different planting methods (Table 2). In the ridge method, ear diameter was respectively 8.5, 16.7 and 23.3 % higher than bed, seeddrill and broadcast methods. The higher ear diameter was largely due to better growth of plant in terms of biomass production under ridge and furrow sowing which might have adequately supplied more photosynthates for development of sink [3]. The test weight of pearl millet indicates that the planting patterns could not influence the test weight of pearl millet significantly (Table 2). However, the maximum test weight of 7.14 g was observed under bed method and the minimum test weight 7.10 g was observed under broadcasting. Ayub et al. [19] found that the effect of sowing methods and sowing date was non-significant on 1000-seed weight of fennel (*Foeniculum vulgare* mill) in both years.

With respect to grain yield, ridge planting had significantly maximum grain yield (18.43 q ha^{-1}), while, broadcast planting had the lowest grain yield (16.52 q ha^{-1}). Grain yield under ridge system was significantly higher due to improving number of tillers as well as ear diameter. According to Jensen et al. [20], maize yield with tied ridging in years with dry to near normal rainfall was improved by 42% even without any nutrient inputs. The maximum pearl millet stover yield of 44.60 q ha^{-1} was recorded under ridge, which was significantly (P= 0.05) greater as compared to rest of the planting methods. Stover yield under ridge method was higher by 1.9 % than bed, 3.7 % than seeddrill and 7.1 % than broadcast planting method. The stover yield was directly proportional to plant biomass and number of tillers. The ridge planting significantly improved stover yield as compared to other planting methods. They tested such as flat planting [21].

Nutritive Value: New planting patterns showed marked influence on the nitrogen content of grain and stover of pearl millet. The maximum nitrogen content in grain was 2.06% and for stover it was 0.65%, both for ridge method (Table 3). Ridge method recorded significantly higher nitrogen content in grains and stover than other methods. The increases in % N from ridge planting method over broadcast, seed drill and bed were respectively 6.91, 5.63 and 4.2% in grain. For the stove N, the respective increases were 7.18, 4.86 and 2.65. Deshmukh *et al*. [18] was obtained similar results. The maximum CP content in grain (12.90% CP) was observed under ridge method. In bed planting, protein content was increased 1.37

and 2.59% over seed drill and broadcast method, respectively. The minimum grain protein content was observed 12.06% under broadcast. This result was comformed by Parihar *et al*. [9] and they stated that the grain protein content was significantly lower in flat sowing as compared to ridge and furrow planting.
The fibers in foods are beneficial for good health. Physiological impacts of insufficient dietary fiber intake are constipation, increased risk of coronary heart disease, and increased fluctuation of blood glucose and insulin levels [22, 23]. The maximum crude fiber content in grain 1.68% was observed for ridge. Ridge planting improved the grain crude fiber content by 13.75, 10.72 and 6.39 per cent over broadcast, seed drill and bed, respectively. The minimum crude fiber content in grain 1.47% was observed under broadcast. The planting arrangement also significantly affects the crude fiber content of sweet corn [24].
Ridge method recorded significantly improved carbohydrates content in grain. The maximum Carbohydrates content in grain 69.16 % was observed under ridge. Ridge planting improved carbohydrates content in grain 1.77 and 1.44 per cent in grain over seed drill and bed, respectively. The minimum Carbohydrates content of 67.74 % in grain was observed under broadcast. The Experimental results are in conformity with Muhammad and Mahmood [25] and stated that the crop grown in ridge was produced significantly higher Grain starch concentration than single rows planting system.
Economics: The economics analysis of experiment was essential to be evaluated that farmer was significantly benefited when farmer applied modified technique in the field. The cost of cultivation was higher when using modified planting system for cultivation. The highest cultivation cost was obtained for ridge and bed planting methods (INR.14000 ha^{-1}), followed by seed drill (Inr. 13950 ha^{-1}). The cultivation cost of broadcast system was 1.79 % lower than seed drill planting method. The cultivation of cost is increase under ridge planting but it is reduced cost of irrigation, irrigation water is the main problem under rainfed region, as well as improved yield of crop [26]. It is obvious from the data (Table 4) reported that the ridge planting patterns recorded gross return of INR. 30741 ha^{-1}, which was 2.39, 4.83 and 8.93% higher than bed, seed drill and broadcast methods, respectively. The gross return was increased due to higher marketable price of grain and stover yield.
The net return was recorded for broadcast (INR. 14520 ha^{-1}), which was 15.30, 10.35 and 5.89% lower than ridge, bed and seed drill methods, respectively. The net return was increased with respect to increasing gross income (in term grain and stover yield). The higher cost-benefit (B: C) ratio 2.20:1 was recorded for ridge followed 2.14:1 and 2.10:1 under bed and seeddrill, respectively. Whereas, it was estimated 2.06:1 for broadcast system. The B: C ratio reflects return per unit investment for the pearl millet cultivation. The ridges and furrow treatment irrespective of land configuration markedly increased the returns and B: C ratio of INR. 14081 ha^{-1} and 1.88:1, respectively, over flat bed treatment and it clearly brings out the fact that adoption of ridges and furrow techniques was more economical than flatbed techniques [27].

Table 1: Effect of different planting methods on growth attributes at different stages of pearlmillet.

Planting pattern	Plant biomass (g $plant^{-1}$)			Tillers (No. $plant^{-1}$)		
	Booting	Physiological maturity	Mean	Booting	Physiological maturity	Mean
Ridge	156.0	253.3	204.6	3.47	4.04	3.76
Bed	145.7	236.7	191.2	3.27	3.77	3.52
Seeddrill	132.6	221.7	177.1	3.00	3.53	3.27
Broadcast	126.6	204.0	165.3	2.82	3.30	3.06
Mean	140.2	228.9	184.6	3.14	3.66	3.40
SEm±	1.92	1.59	1.57	0.03	0.04	0.02
C.D. (*p=0.05*)	4.71	3.90	3.84	0.07	0.09	0.06

Table 2: Effect of different planting methods on yield attributes of pearlmillet.

Planting pattern	Ear diameter (cm)	Yield (q ha^{-1})*		Test weight (g)
		Grain	Stover	
Ridge	3.07	18.4	44.6	7.12
Bed	2.83	17.9	43.8	7.14
Seeddrill	2.63	17.3	43.0	7.13
Broadcast	2.49	16.5	41.75	7.10
SEm±	0.03	0.12	0.27	0.04
C.D. (*p=0.05*)	0.08	0.30	0.66	NS

* q ha^{-1} = quintal (100 kg) per hectare

Table 3: Effect of planting methods on nutritive value parameters of pearlmillet.

Planting pattern	Nitrogen content (%)		Protein content of grain (%)	Crude fiber content of grain (%)	Carbohydrates content of grain (%)
	Grain	Straw			
Ridge	2.06	0.65	12.9	1.68	69.2
Bed	1.98	0.63	12.4	1.58	68.2
Seeddrill	1.95	0.62	12.2	1.51	68.0
Broadcast	1.93	0.60	12.1	1.47	67.7
SEm±	0.01	0.01	0.06	0.02	0.06
C.D. (*p=0.05*)	0.02	0.02	0.14	0.04	0.15

Table 4: Effect of planting methods on economic of pear millet.

Planting pattern	Cost of cultivation (INR. ha^{-1})*	Gross return (INR. ha^{-1})	Net returns (INR. ha^{-1})	B:C ratio
Ridge	14000	30741	16741	2.20:1
Bed	14000	30023	16023	2.14:1
Seeddrill	13950	29325	15375	2.10:1
Broadcast	13700	28220	14520	2.06:1

*INR. ha^{-1} = Indian Rupees per hectare

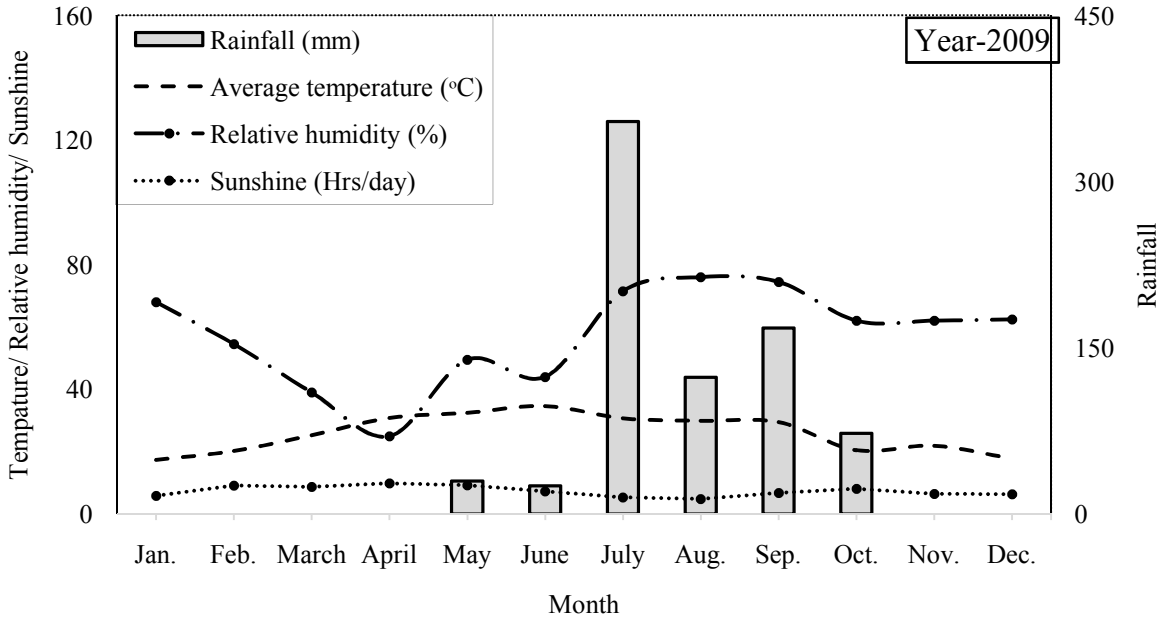

Figure 1: Monthly meteorological data of Vindhyan region during the trial year.

CONCLUSION

From the results of the experiment, new methods of planting were significantly effective for getting higher profitable production of pearl millet than the conventional broadcast method. It is concluded that the ridge planting was most economical planting method for better growth of crop and to obtain higher yields. For the new planting methods, cost of cultivation was slightly higher but production was highly profitable as compared to traditional planting system so, the net returns and B: C ratio of pearlmillet were improved. Ridge planting also improved soil environment and enhance the quality of crop produce due to reducing soil moisture loss and improve uptake of nutrient in soil matrix in semi tropical region of India.

REFERENCES

1. ICRISAT (2007). International Crops Research Institute for the Semi-Arid Tropics. Annual report. Available online at http://test1.icrisat.org /Publications/EBooksOnlinePublications/AnnualReport-2007.pdf
2. Thomas B, Mpofu IDT. (2013). Competitive environment of the staple food distribution system in Namibia: An assessment of the pearl millet (Pennisetum glaucum) industry. Agricultural Science Research J; 3(4): 121-129.
3. FAO & ICRISAT (1996). The world sorghum and millet economies: facts, trends and outlook. A joint study by Food and Agriculture Organization (FAO) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), FAO, Rome; 31-47.

4. Department of Agriculture, Forestry and Fisheries (2011). Pearl millet. Production guideline. Directorate Communication Services, Private Bag X144, Pretoria 0001, South Africa; pp-1. http://www.nda.agric.za /docs/Brochures/PearlmilletPG.pdf
5. ICRISAT (2014). Available online at http://www.icrisat.org/crop-pearlmillet.htm
6. Parihar CM, Rana KS, Jat ML, Jat SL, Parihar MD, Kantwa SR, Singh DK, Sharma S. (2012). Carbon footprint and economic sustainability of pearl millet-mustard system under different tillage and nutrient management practices in moisture stress conditions. African J of Microbiology Research; 6(23): 5052-5061.
7. Harinarayana G. (1987). Pearl Millet in Indian Agriculture. In Proceedings of the International Pearl Millet Workshop, 7-11 April 1986 ICRISAT Center, Patancheru, A. P. 502 324, India. Available online at http://agropedialabs.iitk.ac.in/openaccess/sites/default/files/RA%2000110.pdf
8. Mishra MKJ, Tiwari RC. (1999). Effect of seeding methods and fertilizer application on weed biomass and yield of wheat (Triticum aestivum L.). Indian J of Agronomy; 44(2): 353-356.
9. Parihar CM, Rana KS, Parihar MD. (2009). Crop productivity, quality and nutrient uptake of pearl millet (Pennisetum glaucum) and Indian mustard (Brassica juncea) cropping system as influenced by land configuration and direct and residual effect of nutrient management. The Indian J of Agricultural Sciences; 79(11): 927–930.
10. Rathi JPS, Tripathi AK, Tripathi HN, Kaushal K. (2003). Effect of sowing methods on productivity, economics and seed quality of Indian mustard under irrigated condition in central Uttar Pradesh. Farm Science J; 12(12): 183-185.
11. Jackson ML. (1958). Soil chemical analysis. Prentice-Hall Inc. Englewood Cliffs, New Jersey.
12. AOAC (1990). Official methods of analysis. 15th Edn. Association of Official Analytical Chemists (AOAC), Washington, D.C., p 556.
13. AOAC (1995). Official methods of analysis. 16th Edn. Association of Official Analytical Chemists (AOAC), Washington, D.C.
14. Clegg KM. (1956). The application of the Anthrone reagent to the estimation of starch in cereals. J of the Science of Food and Agriculture; 7(1): 40-44.
15. Gomez KA, Gomez AA. (1984). Statistical Procedures for Agricultural Research. 2nd edn. An International Rice Research Institute Book. A Wiley-Interscience Publication, John Wiley and Sons, New York.
16. Maiti RK, Bidinger FR. (1981). Growth and development of pearl millet plant. Research Bulletin 6, ICRISAT, Hyderabad. p. 24. Available online at http://oar.icrisat.org/1073/1/RA_00343.pdf
17. Araya A, Stroosnijder L. (2010). Effects of tied ridges and mulch on barley (Hordeum vulgare) rainwater use efficiency and production in Northern Ethiopia. Agricultural Water Management; 97: 841–847.
18. Deshmukh SP, Patel JG, Patel AM. (2013). Ensuing economic gains from summer pearlmillet (Pennisetum glaucum L.) due to different dates of sowing and land configuration. African J of Agricultural Research; 8(48): 6337-6343.
19. Ayub M, Nadeem MA, Tanveer A, Tahir M, Saqib MTY, Nawaz R. (2008). Effect of different sowing methods and times on the growth and yield of fennel (Foeniculum vulgare mill). Pakistan J of Botany; 40(1): 259-264.
20. Jensen JR, Berhard RH, Hasen S, McDonagh J, Moberg JP, Nielsen NE, Nordbo E. (2003). Productivity in maize based cropping systems under various soil water management strategies in a semi-arid, alfisol environment in East Africa. Agricultural Water Management; 59: 217–237.
21. Bakht J, Ahmad S, Tariq M, Akber H, Shafi M. (2006). Response of maize to planting methods and fertilizer N. J of Agricultural and Biological Science; 1(3): 8-14.
22. AACC (2001). The Definition of dietary fiber. American Association of Cereal Chemists (AACC). Cereal Foods World; 46: 112-126.
23. Jenkins DJA, Kendall CWC, Ransom TPP. (1998). Dietary fiber, the evolution of the human diet and coronary heart disease. Nutrition Research; 18: 633-652.
24. Saberi AR, Mokhtarpour H. (2013). The effects of sowing density and sowing pattern on quantity and quality yield and some morphological characteristics of sweet corn (Zea mays l.), H.S.C. 403 cultivar. Scientia Agriculturae; 1(2): 56-60.
25. Muhammad R, Mahmood T. (2004). Effect of different planting methods and nutrient management on quality traits of hybrid maize. International Journal of Agriculture and Biology; 6(1): 162–164.
26. Allen RR, Musick JT. (1996). Permanent ridge-till sorghum with furrow irrigation. Applied Engineering in Agriculture; 13(6): 731-736.
27. Deshmukh SP, Patel JG. (2013). Influence of non-monetary and low cost input in sustainable summer pearlmillet (Pennisetum glaucum L.) production. I Journal of Agriculture Food Science & Technology; 4(6): 579-588.