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Response of Date of Sowing and Crop Geometry on Yield Potential of Chia under Tropical conditions

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ABSTRACT: Import of oilseed crops has increased tremendously from the last few decades due to less production and productivity of crops of *brassicaceae* family. Introduction of new crop was the need of hour so as to get an alternate option for other oilseed crops. The experiment was laid out in Factorial Randomized Block design assigning date of sowing (Factor A), plant geometry (Factor B) with three replications to assess the effect of date of sowing and plant geometry performance of Chia. The experiment was conducted at Experimental farm, Agriculture Research Station, Mandor-Jodhpur (Agricultural University, Jodhpur) in the year 2016-17. Factor A consisted of Four different date of sowing *viz.*, 25th October (D_1), 5th November (D_2), 15th November (D_3) and 25th November(D_4) and factor B consisted of four varying plant geometry *viz.*, 30 cm × 30 cm (P_1), 45 cm × 30 cm (P_2), 60 cm × 45 cm (P_3) 90 cm × 45 cm (P_4). Data on biological yield revealed 25th October as best date of sowing of Chia (13505.49 kg ha^{-1}). On the other hand, plant geometry of 30 cm × 30 cm (P_1) also recorded highest values for biological yield (20226.35 kg ha^{-1}). Consequently, data on seed and husk yield per hectare revealed that 25th October (D_1) date of sowing and plant geometry with 45 cm × 30 cm (P_2) recorded significantly higher seed yield and husk yield per hectare than rest of the treatments.

Keywords: chia, biological yield, crop spacing. Husk.

INTRODUCTION

Salvia hispanica L., popularly known by the name chia, is an annual herbaceous plant belonging to the *Lamiaceae* family, is native to the Southern Mexico and northern Guatemala (Ixtaina *et al.*, 2008). Chia being a rich source of ω -3 fatty acids and high content of α-linolenic acid can be cultivated with an expectation of high yield and good quality characteristics. Oil content of white seeds and black seeds of chia is about 33.8% and 32.7%, respectively (Suri *et al.*, 2016. It has an extensive popularity for cultivation in tropical to subtropical regions. Information on chia management is fairly limited (Migliavacca *et al.*, 2014; Busilacchi *et al.*, 2013), especially regarding soil conditions, sowing times, and fertilization. Chia grows well in sandy, well-drained, slightly damp soils. It has a tendency to tolerates acidic soil, but growth is optimal at pH 6.5–8.5 (Pozo and Anabel 2010). However, the potentiality of such crops can fully be realized only after determining their suitable sowing time and plant geometry in a growing region. The yield parameters and their components have been found to vary with planting dates and plant spacing (Freitas *et al.*, 2016). Keeping in view, the inter competition of plants for nutrients, moisture and light; it is quite necessary to work out the optimum spacing indicating plant population/ha (Karim *et al.*, 2015; Yeboah *et al*., 2014). Chia farmers adopt mostly broadcasting seeding method, which results into high density populated plants. The intercultural operations like weeding etc. becomes very much difficult with closely populated plants, which subsequently decreases the yield of chia crop. However, several studies in other countries have justified a closer spacing to increase the yields of *Salvia hispanica*. In Ghana, Yeboah *et al.* (2014), established higher yields ranging from 2790-3208 kg N ha^{-1} in a closer spacing of 0.5 m × 0.5 m. The same was confirmed by Grimes *et al.* (2019) in southwestern Germany when a narrow row spacing of 35 cm was used and resulted to higher seed yields of 1171 kg ha^{-1}. But these reports were contrary to the findings of Mary *et al.*, (2018) who found a higher yield of 579.59 kg ha^{-1} in a wider spacing of 60 cm × 45 cm in the Indian environment. Different spacings are recommended with regard to the environments that Chia is grown (Win *et al.*, 2018). Hence, it becomes essential to study the influence of plant geometry on productivity of chia crop. In pursuance to above fact it is highly needed that experiments on sowing time and crop spacing management of chia must be carried out in the state like Rajasthan so that quality and productivity of the crop can be enhanced as it shows a greater potential towards the sustainability of oilseed crops.

MATERIALS AND METHODS

The site allocated for the experimentation was located at 26º15' upto 26°45' Northern latitude and 73º 00' upto 73º 29' Eastern longitude along with an altitude of 231 meter above MSL at Agricultural Research Station of Agriculture University Jodhpur. That area receives an average of 367 mm rainfall annually and that too 85-90 percent is being received during the month of June to September via South west monsoons.

A. Treatment Details and Experimental Design followed

Total four number of treatments under two factors, replicated 4 times were adopted for the execution of experiment. Two factors (A&B) included crop spacing and crop sowing date. For spacing, four plant geometry *viz.*, 30 cm × 30 cm (P_1), 45 cm × 30 cm (P_2), 60 cm × 45 cm (P_3) 90 cm × 45 cm (P_4) and for sowing different dates *viz.*, 25th October (D_1), 05th November (D_2), 15th November (D_3) and 25th November (D_4) were followed. The experimental variety of chia was Black type seed. Uniformity in application of fertilizer dose was maintained by applying 20 kg N and 40 kg P_2O_5 ha $^{-1}$ as basal dose before sowing through urea and DAP, respectively per plot on an average of 7-8cm away from the seed. Seed rate varied in different treatments due to variation in plot size *i.e.* crop geometry/spacing. Seeds were placed at a depth of 4-5 cm by employing 'kera' method. Proper thinning at 15 DAS was employed to maintain required crop density as per treatment. Intercultural operations were performed as per the requirement of the crop for reduction of crop-weed competition. Ist weeding was performed at 30 DAS and 2nd weeding was done at 60 DAS in all the treatment. Irrigation application at 4 different stages viz. branching, pre-flowering and seed formation and seed hardening stages were performed for maintaining the good crop health, during the growing season. To assess the biological, seed and husk yields, the plants from borders were removed manually first followed by harvesting plants from each net plot at full maturity on different dates and stacked plot wise for sun drying separately, tied in bundles and tagged. These tagged bundles were left for sun drying in the respective plot.

B. Observations and Statistical Analyses

Biological yield: At maturity, weight of total biomass (whole plant) was taken from each net plot after complete drying for estimating biological yield per plot and then converted in to kgha $^{-1}$

Seed yield: After winnowing, cleaned seeds were weighed to record seed yield per plant at moisture content of 12 % and then converted in to kg ha^{-1}.

Husk yield was calculated by subtracting plot wise weight of seed yield from the plot wise weight of inflorescence portion before threshing and then converted in to per hectare (kg). The obtained data was analysed for Factorial Randomised Block Design and result was interpreted for interactions (Panse and Sukhatme 1978).

RESULT AND DISCUSSION

A. Effect of Date of sowing

Among the varying dates of sowing, 25thOctober has recorded significantly highest biological yield per hectare (13505.49 kg ha^{-1}) compared to sowing at 5thNovember, 15th November, and 25th November which were 92.30%, 89.44% and 83.10%, respectively of the highest biological yield per hectare. Progressive delayed sowing resulted in significant reduction in biological yield per hectare of Chia. The minimum biological yield per hectare was recorded when crop was sown on 25th November (11223.32 kg ha^{-1}). The results showed that the variation on biological yield per hectare may be due to different sowing time, higher plant height, maximum number of leaves, higher number of inflorescences, higher dry matter production per plant, environmental factors. These results agree with the findings of Baginsky *et al.* (2016).

A perusal of data (Table 1 & Fig. 1) showed that varying dates of sowing influenced the seed yield per hectare of chia significantly. Sowing on 25th October produced significantly higher seed yield per hectare (512.34 kg ha^{-1}) compared to later sowing on 5th November, 15th November and 25thNovember which were to the extent of 81.50 %, 74.53 % and 51.78 %, respectively of the highest. Progressive delayed sowing resulted in significant reduction in seed yield per hectare of Chia. The minimum seed yield per hectare was recorded when the crop was sown on 25th November (265.29 kg ha^{-1}). A perusal of data showed that varying dates of sowing influenced the husk yield per hectare of chia significantly. Sowing on 25th October produced significantly higher husk yield per hectare (203.87 kg ha^{-1}) compared to delayed sowing dates. The minimum husk yield per hectare was observed when the crop was sown on 25th November (105.72 kg ha^{-1}). Ayerza and Coates (2005), who reported effect of environmental condition causing variation in chia yields. Karim *et al.* (2015) also reported similar decrease in delayed sowing in seed yield and husk yield per hectare of chia.

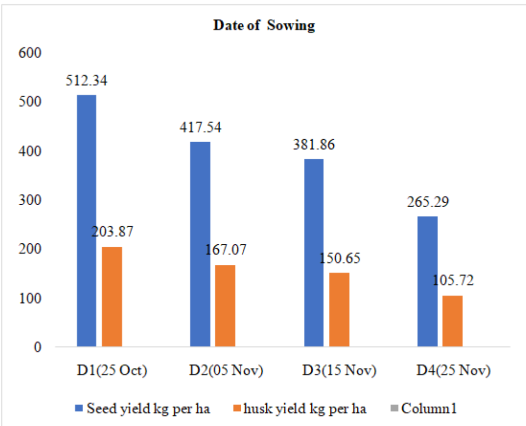

Fig. 1. Effect of date of sowing on seed & husk yield per hectare on chia.

Table 1: Effect of date of sowing and plant geometry on plant population, seed yield and husk yield per hectare on chia.

Treatment	Biological yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Husk yield (kg ha^{-1})
Date of sowing			
D_1 (25th October)	13505.49	512.34	203.87
D_2 (05th November)	12466.14	417.54	167.07
D_3 (15th November)	12078.82	381.86	150.65
D_4 (25th November)	11223.32	265.29	105.72
SEm ±	87.16	11.19	4.21
CD (P = 0.05)	251.73	32.33	12.16
Plant geometry			
P_1 (30 cm × 30 cm)	20226.35	482.65	189.46
P_2 (45 cm × 30 cm)	15065.60	529.70	212.09
P_3(60 cm × 45 cm)	8470.27	345.11	138.88
P_4 (90 cm × 45 cm)	5511.55	219.56	86.88
SEm ±	87.16	11.19	4.21
CD (P = 0.05)	251.73	32.33	12.16

B. Effect of Plant geometry

From data in Table 1 indicated that varying plant geometry had significant effect on biological yield per hectare of chia. Plant geometry of 30 cm × 30 cm recorded significantly highest biological yield per hectare (20226.35 kg) than 45 cm × 30 cm (15065.60 kg), 60 cm × 45 cm (8470.27 kg) and 90 cm × 45 cm (5511.55 kg). The minimum biological yield per hectare (5511.55 kg) was recorded with 90 cm × 45 cm plant geometry. These results were supported by Sharma and Sharma (2014); Raina *et al.* (2013); Adebayo *et al.* (2012); Daneshian *et al.* (2011), Kassahun *et al.* (2011); Solomon & Beemnet (2011).

Different plant geometry treatments (Table 1 & Fig. 2) had significant effect on seed yield per hectare of Chia. Plant geometry of 45 cm × 30 cm recorded significantly higher seed yield per hectare (529.70 kg ha^{-1}) compared to 30 cm × 30 cm, 60 cm × 45 cm and 90 cm × 45 cm inter and intra row spacings which were to the magnitude of 91.12 %, 65.15 % and 41.45 %, respectively of the highest. The minimum seed yield per hectare was recorded by the crop sown at 90 cm × 45 cm plant geometry (219.56 kg ha^{-1}). Data revealed that different plant geometry had significant effect on husk yield per hectare of Chia. Plant geometry of 45 cm × 30 cm recorded significantly higher husk yield per hectare (212.09 kg ha^{-1}) compared to remaining treatments of plant geometry. These results agree with the findings of Freitas *et al.* (2016); Bekhradi *et al.* (2014); Yeboag *et al.* (2014); Daneshian *et al.* (2011).

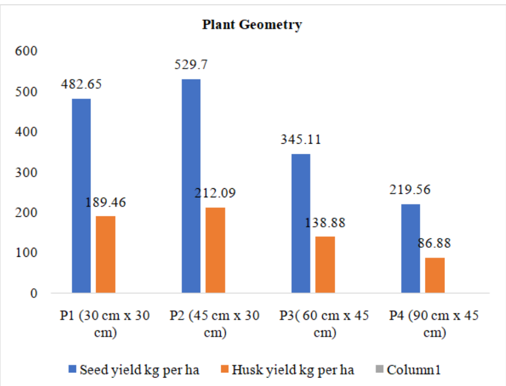

Fig. 2. Effect of plant geometry on seed & husk yield per hectare on chia.

CONCLUSIONS

– Biological yield per hectare was recorded maximum with D_1 (25th October sowing) and P_1 (closer spacing of 30 cm × 30 cm) which was significantly higher over rest of treatments.

– Seed and husk yield per hectare was found maximum with D_1 (25thOctober sowing) which was significantly higher over rest of dates of sowing. Among plant geometry, P_2 (45 cm × 30 cm) recorded significantly higher seed and husk yield per hectare followed by P_1 (30 cm × 30 cm).

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Conflict of Interest. None.

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