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Influence of sowing patterns on the growth and productivity of brinjal, *Solanum melongena*

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In order to investigate the influence of various sowing patterns on the growth and fruit yield of brinjal, the study was carried out during the year 2008 at Sindh Agriculture University Tandojam. Treatments included T1= Raised beds at 60 x 45 cm Intra and Inter row spacing, T2= Raised beds at 90 x 60 cm Intra and Inter row spacing, T3= Ridges at 60 x 45 cm Intra and Inter row spacing, T4= Ridges at 90 x 60 cm Intra and Inter row spacing, T5= Flat bed at 60 x 45 cm Intra and Inter row spacing and T6= Flat bed at 90 x 60 cm Intra and Inter row spacing. The results indicated that on the basis of brinjal fruit yield ha^{-1}, raised bed sowing pattern at 90cm x 60cm intra and inter row spacing ranked 1st with 115.16 cm plant height, 8.69 branches $plant^{-1}$, took 29 days to first flowering, 41 days to first fruit harvest, 14.94 fruits $plant^{-1}$, 183.33 g single fruit weight, 47.11 kg fruit yield $plot^{-1}$ and 34.899 tons fruit yield ha^{-1}. The raised bed sowing pattern at 60cm x 45cm intra and inter row spacing ranked 2nd with 107.66 cm plant height, 7.40 branches $plant^{-1}$, took 27.66 days to first flowering, 41.33 days to first fruit harvest, 12.47 fruits $plant^{-1}$, 170.33 g single fruit weight, 45.10 kg fruit yield $plot^{-1}$ and 33.406 tons fruit yield ha^{-1}. Similarly, ridge sowing at 90cm x 60cm intra and inter row spacing ranked 3rd, flat bed sowing at 90cm x 60cm intra and inter row spacing ranked 5th and flat bed sowing at 60cm x 45cm intra and inter row spacing ranked 6th with simultaneous reduction in fruit yield ha^{-1}.

Key words: Brinjal, Sowing patterns, Inter row spacing, Intra row spacing, Raised bed, Flat bed, growth, yield.

Introduction

The brinjal, *Solanum melongena*, also referred to as eggplants or aubergines, belong to the same family Solanaceae as the potato, tomato and peppers. It bears a fruit of the same name, commonly used as a vegetable in cooking. As a night-shade, it is closely related to the tomato and potato and is native to India and Sri Lanka. The first known written record of the eggplant is found in ancient Chinese agricultural treatise completed in 544 CE. The numerous Arabic and North African names for it, along with the lack of ancient Greek and Roman names, indicate that it was introduced throughout

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theMediterranean area by the Arabs in the early Middle Ages (Fuchsia, 2006 and Wikipedia, 2008).

The plant flourishes in hot climates, but cannot tolerate drought. Brinjals are sensitive to cold weather and are damaged easily by frost. In a crop rotation system, they are grouped in the fruit group (tomatoes, peppers, chillies and potatoes). Because of the crop's high yield, only a few plants (6) are needed to feed a family. Brinjals are low in calories, contain mostly water with some protein, fibre and carbohydrates and no fats. The planting of brinjal may be in 75 cm apart rows better on ridges or raised beds. Soil may be turned using a garden fork to ensure proper aeration of soil and to work in plant rests and weeds into the soil. Brinjals do extremely well in soil with high humus content and the optimum soil pH ranges between 6.5 and 7.5, while water pH may be between 5.5 and 7.0. The nutritive components in 100 g of edible portion of brinjal component composition calories 24.0, moisture 92.7%, carbohydrates 4.0 g, Protein 1.4, Fat 1.3 g, oxalic acid 18.0 mg, calcium 18.0 mg, magnesium (mg) 47.0, iron 0.6 mg, sodium 3.0 mg, copper 0.17 mg, potassium 2.0 mg, sulphur 44.0 mg and chlorine 52.2 mg (Fuchsia, 2006 and Benedictos, 2007). The production of eggplant is highly concentrated, with 93 percent of output coming from seven countries. China is the top producer (55% of world output) and India is second (28%); Egypt, Turkey, and Japan round out the top producing nations. United States is the 20th largest producer. More than 4 million acres (16,000 km^2) are devoted to the cultivation of eggplant in the world (USDA, 2007).

In Pakistan, the area under brinjal during the years 2005-06 and 2006-07 was 8864 and 8480 hectares with a production of 88434 and 86528 tons, while the area under brinjal crop in Sindh province during these years was 2043 and 1553 hectares with a production o f11824 and 9189 tons. There was a sharp decline in area and production of brinjal during the year 2006-07 as compared to preceding year. This decline was probably associated with shortage of irrigation water and problems with the availability of seed nursery (GOP, 2008).

Pakistan is an agricultural country, but unfortunately average farmer is yet to know about the advanced crop production technologies in result, the average yield per unit area of brinjal achieved in our country and particularly in Sindh province is very low. It can be improved, if proper package of production technology is adopted by the average vegetable grower. Although brinjal is cultivated almost in all parts of Pakistan, but little work has been done in Pakistan on knowing the methods of cultivation and crop raising patterns to get the fruit production with reduced cost of production as in the case of developed vegetable growing countries of the world. The studies (Fuchsia, 2006) showed

that spacing of 45 cm to 60 cm between plants, depending on cultivar, and 60 cm to 90 cm between rows under ridge system produced high fruit yields. Keeping the above facts in mind, the experiment was conducted to investigate the influence of various sowing patterns on the growth and fruit yield of brinjal variety "Black Beauty".

Materials and methods

The experiment was conducted during the year 2008 in a three replicated randomized complete block design (RCBD), preparing 18 sub-plots and each measuring 4.5m x 3m (13.50m 2). For raising nursery, the seed of variety "Black Beauty" from the seed market of Hyderabad, and sown in the second week of March. When the seedlings were one and half month old, the transplanting was carried out on 28th April, 2008. The irrigation was applied initially just before transplanting, and afterwards when felt necessary. Following the study plan, the land was in off-season (February-March). Initially, the hard pan of the experimental soil was removed by running disc plow and left for 15 days. Later, the clods were crushed using tractor drawn clod crusher, and leveling was performed. These field operations were performed to make the soil leveled to receive irrigation water uniformly. Moreover, eradication of weeds was ensured before applying the soaking dose. After application of soaking dose, the experimental land was once again examined whether it is leveled uniformly; and spots and bund sides found raising were leveled to reach the irrigation water feasibly and evenly in all the plots. After soaking dose, when the land came in condition, the plots were finally prepared by giving separation strips and forming feeding channels. NPK fertilizers were applied at the recommended dose of 100-100-75 kg ha^{-1}. Nitrogen was applied in the form of Urea (46%) in three splits, while phosphorus and potash were applied in the form of SSP (18 %P_2O_5) and muriate of potash. All P and K alongwith 1/3rd of N was done at the time of sowing, while the remaining N was divided into two splits and applied at first and third irrigations, respectively. Irrigations were applied as per the schedule. The recommended cultural practices were performed in all the subplots. Five plants in each treatment were selected at random to record observations. These sample plants were labeled and numbered for differentiation. The data so collected were tabulated replication-wise on basis of five randomly selected plants, and then averages were worked out. Statistical analysis of the data was done to discriminate the superiority of treatment means, using L.S.D (Least Significant Differences) test, as per the statistical methods developed by Gomez and Gomez (1984). All the statistical tests were performed by using Mstat-C Micro-Computer Statistical Software.

Results

Plant height (cm)

The brinjal transplanted on raised beds at 90cm x 60cm intra and inter row spacing produced averagely tallest plants of 115.66 cm, followed by the transplanting on ridges at 90cm x 60cm intra and inter row spacing with average plant height of 111.00 cm. Similarly, the plant height averaged at 107.66 cm when the brinjal was transplanted on raised beds at 60cm x 45 cm intra and inter row spacing system, closely followed by transplanting on ridges at 60cm x 45cm intra and inter row spacing with average plant height of 106.67 cm. The plant height was markedly reduced to 103.00 cm when brinjal was transplanted on flat bed system at 90cm x 60cm intra and inter row spacing, while the lowest plant height of 97.33 cm was recorded also under the flat bed sowing system at 60cm x 45cm intra and inter row spacing (Table-1).

Number of branches plant^{-1}

It is apparent from the results that the brinjal transplanted on raised beds at 90cm x 60cm intra and inter row spacing resulted in maximum number of branches (8.69 plant^{-1}), followed by the transplanting on ridges at 90cm x 60cm intra and inter row spacing and brinjal transplanted on raised beds at 60cm x 45cm intra and inter row spacing with 7.42 and 7.40 average number of branches plant^{-1}, respectively. Similarly, the number of branches was reduced to 6.63, when the brinjal was transplanted on ridges at 60cm x 45 cm intra and inter row spacing system, closely followed by transplanting in flat bed at 90cm x 60cm intra and inter row spacing with 6.47 average number of branches plant^{-1}. The number of branches was considerably reduced to its minimum (5.81 plant^{-1}), when brinjal was transplanted on flat bed system at 60cm x 45cm intra and inter row spacing (Table-1).

Number of days taken to first flowering

It can be seen from the results (Table-1) that the brinjal transplanted on raised beds at 90cm x 60cm intra and inter row spacing, ridges at 90cm x 60cm intra and inter row spacing, flat bed at 90cm x 60cm intra and inter row spacing and flat bed at 60cm x 45cm intra and inter row spacing took equally 29.00 days to first flowering, respectively. However, brinjal transplanted on ridges at 60cm x 45cm intra and inter row spacing resulted first flowering averagely in 28.66 days, while transplanting on raised beds at 60cm x 45cm intra and inter row spacing took minimum (27.66) days on average to first flowering.

Number of days taken to first fruit harvest

It is apparent from the results that the brinjal transplanted on ridges at 60cm x 45cm intra and inter row spacing took relatively greater number of days (42.33) to first fruit harvest, followed by ridge sowing at 90cm x 60cm intra and inter row spacing or flat bed sowing at 90cm x 60cm intra and inter row spacing, where the crop equally took 42.00 days to first fruit harvest, respectively. The brinjal transplanted on flat bed at 60cm x 45cm intra and inter row spacing resulted first fruit harvest averagely in 41.66 days, while transplanting on raised beds either at 60cm x 45cm or 90cm x 60 cm intra and inter row spacing took equally minimum (41.33 days) on average to first fruit harvest (Table-1).

Table 1. Mean Plant height, branches plant^{-1}, days taken to flowering and 1st fruit harvest of brinjal as influenced by different sowing patterns

Treatments	**Plant height (cm)**	**No.of branches plant^{-1}**	**No.of days to flowering**	**No.of days to 1st fruit harvest**
T1= Raised beds at 60 X 45 cm Intra and Inter row spacing	107.66bc	7.40 b	27.66	41.33
T2= Raised beds at 90 X 60 cm Intra and Inter row spacing	115.66a	8.69 a	29.00	41.33
T3= Ridges at 60 X 45 cm Intra and Inter row spacing	106.67bc	6.63 c	28.66	42.33
T4= Ridges at 90 X 60 cm Intra and Inter row spacing	111.00ab	7.42 b	29.00	42.00
T5= Flat bed at 60 X 45 cm Intra and Inter row spacing	97.33d	5.81 d	29.00	41.66
T6= Flat bed at 90 X 60 cm Intra and Inter row spacing	103.00c	6.47 c	29.00	42.00
S.E.±	0.9359	0.0629	0.5561	0.5092
LSD 0.05	3.933	0.2602	NS	NS
LSD 0.01	5.388	0.3564	NS	NS
CV%	4.14	3.13	4.74	2.99

Mean values with same letters do not differ significantly at 0.05 probability level.

Number of fruits plant^{-1}

The brinjal transplanted on raised beds at 90cm x 60cm intra and inter row spacing produced maximum number of fruits (14.93) plant^{-1}, followed by the transplanting on ridges at 90cm x 60cm intra and inter row spacing and brinjal transplanted on raised beds at 60cm x 45cm intra and inter row spacing with 12.84 and 12.47 average number of fruits plant^{-1}, respectively. However, the number of fruits was reduced to 11.62, when the brinjal was transplanted on ridges at 60cm x 45 cm intra and inter row spacing system, closely followed by

transplanting in flat bed at 90cm x 60cm intra and inter row spacing with 10.26 average number of fruits plant^{-1}. The number of fruits was markedly reduced to its minimum level (8.89 plant^{-1}), when brinjal was transplanted on flat bed system at 60cm x 45cm intra and inter row spacing (Table-2).

Weight of single fruit (g)

It is evident from the results that the brinjal transplanted on raised beds at 90cm x 60cm intra and inter row spacing resulted in single fruit weight of 183.33 g, followed by the transplanting on ridges at 90cm x 60cm intra and inter row spacing and raised beds at 60cm x 45cm intra and inter row spacing with 173.00 and 170.33 g average weight of single fruit, respectively. However, the weight of single fruits was decreased considerably to 161.00 g, when the brinjal was transplanted on flat beds at 90cm x 60cm intra and inter row spacing system, closely followed by transplanting on ridges at 60cm x 45cm intra and inter row spacing with 154.66 g average weight of single fruit. The number of fruits was further decreased and reached to minimum (152.66 g), when brinjal was transplanted on flat bed system at 60cm x 45cm intra and inter row spacing (Table-2).

Fruit yield ha^{-1} (tons)

The brinjal crop transplanted on raised beds at 90cm x 60cm intra and inter row spacing produced significantly highest fruit yield of 34.899 tons ha^{-1}, closely followed by transplanting on raised beds at 60cm x 45cm intra and inter row spacing with average fruit yield of 33.406 tons ha^{-1}. The brinjal seedlings transplanted on ridges at 90cm x 60cm intra and inter row spacing produced fruit yield of 30.775 tons ha^{-1}, while the yield ha^{-1} was reduced to 29.412 tons when transplanting was done on ridges at 60cm x 45cm intra and inter row spacing. The results further showed that the fruit yield was decreased to 28.114 tons ha^{-1} when brinjal was transplanted on flat bed at 90cm x 60cm intra and inter row spacing. However, the fruit yield ha^{-1} reached to its lowest i.e. 26.802 tons ha^{-1} when transplanting was done on flat bed at 60cm x 45cm intra and inter row spacing (Table-2).

Table 2. Mean number of fruits plant^{-1}, weight of single fruit and fruit yield ha^{-1} of brinjal as influenced by different sowing patterns

Treatments	No.of fruits plant^{-1}	Weight of single fruit (g)	Fruit yield (t ha^{-1})
T1= Raised beds at 60 X 45 cm Intra and Inter row spacing	12.47 b	170.33 bc	33.406 a
T2= Raised beds at 90 X 60 cm Intra and Inter row spacing	14.93 a	183.33 a	34.899 a
T3= Ridges at 60 X 45 cm Intra and Inter row spacing	11.62bc	154.66 d	29.412 bc
T4= Ridges at 90 X 60 cm Intra and Inter row spacing	12.84 b	173.00 ab	30.775 b
T5= Flat bed at 60 X 45 cm Intra and Inter row spacing	8.89 d	152.66 d	26.802 d
T6= Flat bed at 90 X 60 cm Intra and Inter row spacing	10.26cd	161.00 cd	28.114 cd
S.E.±	0.2759	2.0507	0.2846
LSD 0.05	1.1600	8.6170	1.196
LSD 0.01	1.5890	11.810	1.638
CV%	5.71	3.03	2.28

Mean values with same letters do not differ significantly at 0.05 probability level.

Discussion

The developments and further innovations in crop production technologies in the developed countries of the world is a regular feature and subsequently they are far ahead of our farmers. Although brinjal is cultivated almost in all parts of Pakistan, but little work has been done on knowing the methods of cultivation and crop raising patterns to get the high fruit production with reduced cost. According to Fuchsia (2006), there is a number of sowing patterns with varying spacing. The sowing systems included ridge sowing, flat bed sowing, raised bed sowing, etc. with change of between and within row spacing.

The results of the present study indicated that on the basis of brinjal fruit yield ha^{-1}, raised bed sowing pattern at 90cm x 60cm intra and inter row spacing ranked 1st with 115.16 cm plant height, 8.69 branches plant^{-1}, took 29 days to first flowering, 41 days to first fruit harvest, 14.94 fruits plant^{-1}, 183.33 g single fruit weight, 47.11 kg fruit yield plot^{-1} and 34.899 tons fruit yield ha^{-1}. It was concluded from the results that there was remarkable difference in brinjal fruit yield ha^{-1} when the effect of sowing pattern or intra and inter row spacing is taken into account. The fruit yield ha^{-1} was greatly influenced by sowing pattern and raised bed system showed superior fruit yields when compared with ridge system and flat bed system. These results are partially supported by Benedictos (2000) who examined the effect of sowing patterns based on plant and row spacing for brinjal, and ridge sowing at 100 x 40 cm spacing intra and inter row spacing showed the highest mean yields of 40 tons ha^{-1}. Similarly, Hassan (2000) reported that increasing plant density significantly reduced early fruit weight/plant, total number and weight of fruit/plant and increased the

average fruit weight, but considered spacing 80 cm apart for higher brinjal fruit yields.

A considerable research on the similar aspects of brinjal has been carried out world over. From India, Singh and Syamal (2001) reported highest brinjal fruit yield at the spacing of 60 cm X 60 cm. In Portugal, Paturde *et al*. (2002) obtained higher fruit yields in brinjal under ridge sowing system, while in India Vijayakumar *et al*. (2002) recommended 75 x 60 cm intra and inter row spacing in brinjal for highest yields. In another study, Black e*t al.* (2003) reported that brinjal was cultivated on 8" raised beds combined to compare the yield performance by ridge method of planting and fruit yield was highest in the flat bed treatment when compared to any treatment that used a raised bed; while from India Harminder *et al*. (2003) reported that plant spacing at 75 x 45 had maximum plant height, days to first fruit picking, and number of fruits per plant and marketable and total yield. The results reported by Pessarakli and Dris (2003) conclude that 90 x 120 plant and row spacing and sowing on ridges resulted higher fruit yields per plant as compared to rest of the planting systems and spacing.

Few more studies have been published which are well in line with the findings of the present study. Silva and Silva (2005) reported that brinjal plants were spaced about 500 mm apart in rows drawn 75 cm to 150 cm apart and reported higher fruit yields, while Fuchsia (2006) suggested ridge system of sowing brinjal with spacing of 45 cm to 60 cm between plants, depending on cultivar, and 60 cm to 90 cm between rows for producing high fruit yields. Similarly, Kogbe (2006) recommended that both the local and exotic brinjal varieties be planted at a spacing of 90 x 60cm. In another similar study, Benedictos (2007) found that the highest brinjal fruit yield was obtained with the spacing of 75 × 40 cm. The Ikissan (2007) in India, found that 90cm apart rows either in the plain beds or on ridges proved superior in terms of fruit yield of brinjal. The comparative scenario of the findings of the present study and researches carried out in other parts showing concurrence, but with few of the studies entire agreement has been noted, while few others have partial agreement with the findings of the present research.

Conclusion

It was concluded from the results that there was remarkable difference in brinjal fruit yield ha^{-1} when the effect of sowing pattern or intra and inter row spacing is taken into account. The fruit yield ha^{-1} was greatly influenced by sowing pattern and raised bed system showed superior fruit yields when compared with ridge system and flat bed system.

References

Benedictos, P. (2007). Optimum planting pattern for eggplant cv. Avan. ISHS ActaHorticulturae 533: Proc. VIII International Symposium on Timing Field Production in Vegetable Crops, pp. 110-113.

Benedictos, P., Jr. (2000). Optimum planting density for eggplant cv. 'Avan'.ActaHorticulturae. 533 :167-169.

Black, L. L., Wu, D.L., Wang, J.F., Kalb, T., Abbass D. and Chen, J.H. (2003). An Integrated Approach to Manage brinjal Crop. AVRDC International Cooperator's Guide Pub No. 03-551.

Fuchsia, D. (2006). Revolutionary Chinese Cookbook: Recipes from Hunan Province, Ebury Press, Hunan, China.

Gomez, K.A. and Gomez, A.A. (1984). Statistics for Agricultural Research (Second Edition). John Willey and Sons, New York.

GOP. 2008. Province-wise area and production of vegetables in Pakistan (2006-2007). Statistical Year Book, Government of Pakistan, Islamabad.

Harminder, S., Saimbhi, M.S. and Bal, S.S. (2003). A note on effect of plant population density on growth and yield of brinjal hybrids.Vegetable Science 24(2):164-166.

Ikissan (2007). Brinjal Crop Establishment. IKissan.com. Pp. 1-6.

Kogbe, J.O.S. (2006). Effects of spacing on the yield of local and exotic species of egg plant. ISHS ActaHorticulturae 123: Proc. VI African Symposium on Horticultural Crops, pp. 341-344.

Paturde, J.T., Wankhade, S.G., Khode, P.P. and Khan, A.H. (2002). Performance of ArkaMahima (Tetraploid) against ArkaSanjeevini (Diploid) varieties of wild brinjal (SolanumviarumDunal) under different plant spacings and fertility levels.Agricultural Science Digest 22 (1):67-68.

Pessarakli, M.M. and Dris, R. (2003). Effects of pruning and spacing on the yield and quality of eggplant. Journal of Food, Agriculture & Environment 1(2):215-216.

Hassan, M.N.M. (2000). Effect of plant density and additional dose of nitrogen after the first harvest on eggplant cv. "Black Beauty".Assiut Journal of Agricultural Sciences. 24(2):133-148.

Silva, U.D. and Silva, R.A. (2005). Eggplant production Evaluation under normal friable soils the north-west region of Minas Gerais. HorticulturaBrasileira. 17(1-2):231-235.

Singh, V.N. and Syamal, M.M. (2001). Effect of nitrogen and spacing on yield and quality attributes of brinjal, *Solanum melongena* L. Journal of Research, Birsa Agricultural University 7(2):137-139.

USDA (2007). Vegetables and Melons Outlook/VGS-318.Economic Research Service 23. USDA (Retrieved on 24-04-2007).

Vijayakumar, A., Arunachalam, M. and Suthanthirapandian, I.R. (2002). Influence of mother crop nutrition and spacing on seed yield and quality in brinjal.South Indian Horticulture. 43(5-6):152-153.

Wikipedia. (2008). Eggplant: From Wikipedia, the free encyclopedia. Page was last modified and updated on 10 April 2008. Wikipedia® is a registered trademark of the Wikimedia Foundation, Inc. USA.

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