Malaysian Journal of Sustainable Agriculture (MJSA)
***DOI** : http://doi.org/10.26480/mjsa.02.2019.16.19*

ISSN: 2521-2931 (Print)
ISSN: 2521-294X (Online)
CODEN : MJSAEJ

RESEARCH ARTICLE

INTERCROPPING OF POTATO WITH BRINJAL

Jubaidur Rahman[1*], Monira Yasmin[2], Fouzia Sultana Shikha[3], Majharul Islam[4], Mukaddasul Islam Riad[5]

[1]Scientific Officer, Agronomy Division, Bangladesh Agricultural Research Institute, Jamalpur-2000, Bangladesh
[2]Scientific Officer, Soil Science Division, Bangladesh Agricultural Research Institute, Jamalpur-2000, Bangladesh
[3]Scientific Officer, Soil Science Division, Bangladesh Agricultural Research Institute, Jamalpur-2000, Bangladesh
[4]Scientific Officer, Soil Science Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh-2200, Bangladesh
[5]Scientific Officer, Plant Genetic Resources Centre, Bangladesh Agricultural Research Institute, Jamalpur-2000, Bangladesh
***Corresponding Author Email:** jubaidurjp@gmail.com*

ARTICLE DETAILS

Article History:

Received 4 January 2019
Accepted 19 February 2019
Available online 21 February 2019

ABSTRACT

A field experiment was conducted to find out the spacing of potato - brinjal intercropping system and land utilization and economic return at the Regional Agricultural Research Station, Jamalpur during rabi 2017-2018. The experiment was laid out in randomized complete block design (RCBD) with three (3) replications and six treatments. Cultivation of potato with brinjal at potato (60 cm × 25 cm) + brinjal (120 cm × 75 cm), Potato (50 cm × 20 cm) + Brinjal (100 cm × 70 cm), Potato (50 cm × 20 cm) + Brinjal (100 cm × 75 cm) might be agronomically feasible and economically profitable for potato and brinjal intercropping system as compared to sole treatment. Potato (50 cm × 20 cm) + Brinjal (100 cm × 70 cm) best performed in gross return, gross margin and potato equivalent yield (PEY 49.14 tha^{-1}) compared with the other treatments. The total yield of intercropped crops was greater than sole cropping, shown by LER>1. The overall advantage of intercropping ranged from 73 to 92%. The highest land equivalent value of 92% was recorded for Potato (50 cm × 20 cm) + Brinjal (100 cm × 70 cm) arrangements indicated a yield advantage of 92% over sole crop. Viable agronomic option in increasing land use efficiency and increased food security. It is, therefore, imperative to demonstrate the best treatment under farmer's condition.

KEYWORDS

Potato, Brinjal, Intercropping, Land utilization

1. INTRODUCTION

Bangladesh is one of the major horticultural countries in South Asia. Brinjal (*Solanummelongena* L.) is an important vegetable for its commercial and nutritional value in the world as well as in Bangladesh. "Begoon" (Brinjal or Eggplant) is a very common and favorite vegetable in Bangladesh which has a link with the social, cultural and economic lives of rural people. Brinjal is the most important vegetable of the country. Brinjal *(Solatium melongena),* Linnaeus belongs of the family Solanaceae is also known as eggplant or aubergine is a popular nutritious and grown vegetable in Bangladesh as well as in the world and has got multifarious use as a dish item It is thought to be originated in Indian subcontinent because of maximum of genetic diversity and closely related species of solanuin are grown in this reason. Potato is the number one vegetable crop of Bangladesh both in terms of area and production [1]. It alone constitutes more than 50% of the total annual vegetable production in the country [2]. In northern part of Bangladesh Potato-Maize-Transplant aman rice turning into a major cropping pattern nowadays [3]. Also, Jamalpur region Potato is the most important crop in area and production in Bangladesh especially in char. Jamalpur district which most potato growing area of Bangladesh 1643 acres area produced 6238 MT [4]. The use of an intercropping system is one method of increasing crop productivity and intensity of crops [5]. Intercropping has several advantages such as additional income from companion crops, insurance against crop failure, increase productivity, stability of production, and maximization of products, soil fertility and pest control [6-8]. The inventory of main river char lands estimated their total area at 8,444 km^2 or almost 6% of Bangladesh [9]. Due to decreasing cultivable land, some farmers of char areas (river flood plain) under greater Mymensingh district (together five district) in Bangladesh have been practicing garden pea with onion, coriander with onion and vegetables, pulse and oilseed crops with wheat are common practice to the farmers of char areas [10-12]. Brinjal and potato are the most important crop in area and production in Bangladesh especially in char. Jamalpur district which most brinjal production area of Bangladesh 6987 acres area produced 25449 MT [13]. Farmers of this area practiced intercropped potato with brinjal and after harvest. But they do not know suitable combination of intercropped system. This suggests that the system can help to raise productivity to achieve food security, but the system has never been researched and no studies have been made to improve the productivity of the system. To this effect, an experiment was conducted at Jamalpur to assess the compatibility of the companion crops and identify best cropping ratio that maximize land use efficiency.

2. METHODS AND MATERIALS

The district lies between 24°34′ and 25°26′ north latitudes and between 89°40′ and 90°12′ east longitudes and it is situated at elevation 23 meters above sea level**.** The annual average temperature of this district varies from maximum 33.3°C to minimum 12°C. Annual average rainfall is 2174 mm. The experimental site was of medium high land belonging to the agro-

ecological zone Old Brahmaputra Floodplain under Agro-Ecological Zone 9 [14]. The experiment was conducted at the Regional Agricultural Research Station, Jamalpur during *rabi* 2017-2018 to find out the spacing of potato - brinjal intercropping system and land utilization and economic return. Design of the experiment was RCB with 03 (three) replications having the unit of plot 3m × 3.75m. BARI Alu – 25 (Asterix) and BARI Begun-8 were used as a variety in the experiment. Treatments included in the experiment were: T_1 = Sole potato (50 cm × 20 cm), T_2 = Sole brinjal (100 cm × 75 cm), T_3 = potato (50 cm × 20 cm) + Brinjal (100 cm × 60 cm), T_4 = potato (50 cm × 20 cm) + Brinjal (100 cm × 70 cm), T_5 = potato (50 cm × 20 cm) + Brinjal (100 cm × 75 cm), T_6 = potato (60 cm × 25 cm) + Brinjal (120 cm × 75 cm). Fertilizers were applied for sole potato: N:P_2O_5:K_2O:S @ 160:100:160:20 kg /ha and sole brinjal 80-24-60-10-1.0-0.3 kg/ha N-P-K-S-Zn-B fertilizers were applied in the form of Urea, triple super phosphate, Muriate of potash, Zypsum, Zinc Sulphate and Boric acid respectively [15]. For sole potato at the time of final land preparation cow dung @ 10 t/ha was applied and other fertilizers were applied as following doses. For sole brinjal: Half cow dung should be applied during the final land preparation. Remaining cowdung and full phosphorus, sulphur, zinc and boron should be applied in three equal splits 21, 35 and 50 days after transplanting. Potato sown on November 23, 2017 and Brinjal: November 30, 2017. Intercultural operations like watering, weeding and spraying insecticides were followed as and when necessary. One pheromone trap was used for everyone decimal land to control of brinjal fruit and shoot borer. Irrigation was applied two times during the potato growing period and brinjal was grown when necessary. Yield of potato and yield of brinjal was calculated in t ha^{-1} considering the whole plot harvest area. Five plants of brinjal in each plot were selected randomly to collect data on yield components. Collected data were analyzed statistically with the help of STAR software and mean separation was done as per LSD test at 5% level of significance. Economic analysis was performed considering the price of potato and brinjal prevailed at the harvesting period in the local market. Potato equivalent yield (PEY) was also calculated considering the local market price at the harvesting time following the formula as stated by a researcher [16]. LER indicates the efficiency of intercropping for using the resources of the environment compared with mono-cropping [17]. The LER was calculated as follows: Land equivalent ratio (LER) = (YAB/YAA) + (YBA/YBB) [18].

Where:
YAB=yield of crop A (potato) when intercropped with crop B (brinjal)
YBA=Yield of crop B (brinjal) when intercropped with crop A (potato)
YAA=Yield from sole planted crop A (potato)
YBB=Yield from sole planted crop B (brinjal)

3. RESULTS AND DISCUSSION

3.1 EFFECT OF POTATO

Yield and yield components like plant height, plant m^{-2}, no. of stem $plant^{-1}$, no. of tuber $plant^{-1}$, tuber weight $plant^{-1}$, 10 tuber weight and tuber yield differed significantly influenced by different intercropping system (Table 1). The highest plant height was found in Potato (50 cm × 20 cm) + Brinjal (100 cm × 75 cm) due to intercrop competition for densely population. No. of tuber $plant^{-1}$ was found from sole potato (50 cm × 20 cm) might be due to free space. 10 Tuber wt was the highest in potato (60 cm × 25 cm) + Brinjal (120 cm × 75 cm) because of higher potato spacing than others treatment. The highest yield was observed in sole potato due to less competition to nutrient supply. Several authors have reported the superiority of maize/potato intercropping to sole [19,20].

Table 1: Yield and yield components of potato in potato-brinjal intercropping system (Jamalpur 2017-18)

Treatment combination	Plant height(cm)	Plant/m^2	No.of stem/ plant	No.of tuber/plant	Tuber wt./plant (gm)	10 Tuber wt.(gm)	Tuber yield (t/ha)	PLERP
T_1	71.5	6.33	5	10.47	597	730	25.78	1
T_2	-	-	-	-	-	-	-	-
T_3	67.3	6.67	4	7.7	616	817	22.31	0.87
T_4	68.9	6.33	4	7.7	520	800	24.13	0.94
T_5	74	6.33	4	8.2	537	533	22.61	0.88
T_6	71.2	7	5	9.1	602	838	21.93	0.89
$LSD_{0.05}$	4.2	1.8	0.6	0.72	26.14	23.96	1.27	-
CV (%)	2.48	11.93	5.83	3.55	7.5	1.36	2.31	-

T_1 = Sole potato (50 cm × 20 cm), T_2 = Sole brinjal (100 cm × 75 cm), T_3 = potato (50 cm × 20 cm) + Brinjal (100 cm × 60 cm), T_4 = potato (50 cm × 20 cm) + Brinjal (100 cm × 70 cm), T_5 = potato (50 cm × 20 cm) + Brinjal (100 cm × 75 cm), T_6 = potato (60 cm × 25 cm) + Brinjal (120 cm × 75 cm)

3.2 Effect of brinjal

Yield and yield components like plant height, single fruit weight, fruit length, fruit breadth, no. of fruit/plant, weight of fruit/plant and yield differed significantly influenced by different intercropping system (Table 2). The highest plant height was found in Potato (50 cm × 20 cm) + Brinjal (100 cm × 75 cm) due to closer spcing of brinjal population and the lowest from potato (50 cm × 20 cm) + brinjal (100 cm × 70 cm). Single fruit weight was obtained from sole brinjal (100 cm × 75 cm) might be due to over space to increased side branching. Fruit length, fruit breadth, no. of fruit/plant, weight of fruit/plant was highest from sole brinjal (100 cm × 75 cm). The highest yield was observed in sole brinjal (100 cm × 75 cm) which was statistically similar to potato (50 cm × 20 cm) + brinjal (100 cm × 70 cm).

Table 2: Yield and yield components of brinjal in potato - brinjal intercropping system (Jamalpur 2017-18)

Treatment combination	Plant height(cm)	Single fruit wt.(gm)	Fruit length (cm)	Fruit breadth (cm)	No. of fruit/5 plant	Wt.of fruit/5 plant (gm)	Yield (t/ha)	PLERB
T_1	-	-	-	-	-	-	-	-
T_2	93.3	84.93	20.11	3.75	127.7	9720	19.1	1
T_3	92.83	80.27	19.57	3.39	93.33	7983	16.45	0.86
T_4	90.02	81.37	19.55	3.49	91.33	8533	18.76	0.98
T_5	94.23	83.57	19.58	3.59	101.7	8536	17.62	0.92
T_6	91.99	81.47	19.75	3.62	100	8570	18.58	0.97
$LSD_{0.05}$	5.3	6.3	1.54	0.45	4.24	86.12	1.81	-
CV (%)	2.4	3.23	3.31	5.34	1.74	0.42	4.22	-

T_1 = Sole potato (50 cm × 20 cm), T_2 = Sole brinjal (100 cm × 75 cm), T_3 = potato (50 cm × 20 cm) + Brinjal (100 cm × 60 cm), T_4 = potato (50 cm × 20 cm) + Brinjal (100 cm × 70 cm), T_5 = potato (50 cm × 20 cm) + Brinjal (100 cm × 75 cm), T_6 = potato (60 cm × 25 cm) + Brinjal (120 cm × 75 cm)

3.3 Combined yield

The highest combined yield of the crops (42.89 t ha^{-1}) was obtained from potato (50 cm × 20 cm) + brinjal (100 cm × 70 cm) (Table 3). The highest yield in the intercropping treatment could be attributed to growing spaces being varied; temporal growth variance between two varying crops; a combined increase in making better use of light, soil moisture content and nutrients as discussed by a researcher. The highest yield in intercropping

as opposed to sole cropping was supported by several studies. Partial LERs for potato and brinjal grown in the intercropping systems are less than unity (Table 3) indicating that both potato and brinjal are compatible for intercropping under different cropping intensities. The highest PLER for potato (0.94) and brinjal (0.98) was recorded for potato (50 cm × 20 cm) + brinjal (100 cm × 70 cm) compared with Potato (50 cm × 20 cm) + Brinjal (100 cm × 75 cm) treatment combination. The highest TLER for potato (0.94) and brinjal (0.98) was recorded from (50 cm × 20 cm) + brinjal (100 cm × 70 cm)

Table 3: Effect of arrangement of potato-brinjal intercropping on combined yield and land equivalent ratios of the component crops

Treatment combination	Combined yield (t ha^{-1})	PLER P	PLERB	TLER
Sole potato (50 cm × 20 cm)	25.78	1	-	1
Sole brinjal (100 cm × 75 cm)	19.1	-	1	1
Potato (50 cm × 20 cm) + Brinjal (100 cm × 60 cm)	38.76	0.87	0.86	1.73
Potato (50 cm × 20 cm) + Brinjal (100 cm × 70 cm)	42.89	0.94	0.98	1.92
Potato (50 cm × 20 cm) + Brinjal (100 cm × 75 cm)	40.23	0.88	0.92	1.8
potato (60 cm × 25 cm) + Brinjal (120 cm × 75 cm)	40.51	0.89	0.97	1.86

PLERP = partial land equivalent ratio potato, PLERB = partial land equivalent ratio brinjal. TLER= total land equivalent ratio

3.4 Land Equivalent Ratio (LER)

Total LER was significantly different from 1.00 in all intercropping treatments, which shows an advantage over pure stands in terms of the use of environmental resources for Plant growth as reported by previous researcher [21-30]. In this study, TLER ranged from 1.73 to 1.92. The intercropped yield advantage in terms of total LER indices was greatest in the cases of Potato (50 cm × 20 cm) + Brinjal (100 cm × 70 cm) intercropping arrangement (1.92) which might be attributed to more efficient total resource exploitation and greater overall production as opposed to the other intercropping treatments [31-38]. This indicated that additional 0.92 ha (92%) more area would have been needed to get equal yield to planting potato and brinjal in pure stands. This result is in agreement with the findings of several other intercropping studies, a researcher demonstrated the advantages of intercropping systems where, LER of greater than 1 was recorded [39-41]. This might indicate that in a suitable combination plants can complement each other in a more efficient use of environmental resources, mainly light, water and nutrients. The current intercropping systems demonstrate that farmers could benefit by growing the Potato (50 cm × 20 cm) + Brinjal (100 cm × 70 cm) in Jamalpur region.

3.5 Economics

Intercropping of potato with brinjal was more profitable than sole cropping of brinjal. The maximum cost of cultivation Tk. 135000 ha^{-1} was found in potato brinjal intercropping system while the minimum cost of cultivation Tk. 110000 ha^{-1} was found in sole potato cultivation systems. The maximum gross return Tk. 737100 ha^{-1} was obtained from Potato (50 cm × 20 cm) + Brinjal (100 cm × 70 cm) followed by the potato (50 cm × 20 cm) + brinjal (100 cm × 75 cm). The maximum gross margin Tk. 607100 ha^{-1} was obtained from potato (50 cm × 20 cm) + brinjal (100 cm × 75 cm).

Table 3: Economics of potato-brinjal intercropping system during *rabi* 2017-2018

Treatment combination	PEY	Cost of cultivation (Tk. ha^{-1})	Gross return (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})	BCR
Sole potato (50 cm × 20 cm)	25.78	110000	386700	276700	3.52
Sole brinjal (100 cm × 75 cm)	25.46	120000	381900	261900	3.18
Potato (50 cm × 20 cm) + Brinjal (100 cm × 60 cm)	44.24	135000	663600	528600	4.92
Potato (50 cm × 20 cm) + Brinjal (100 cm × 70 cm)	49.14	130000	737100	607100	5.67
Potato (50 cm × 20 cm) + Brinjal (100 cm × 75 cm)	46.10	125000	691500	566500	5.53
Potato (60 cm × 25 cm) + Brinjal (120 cm × 75 cm)	46.70	123000	700500	577500	5.70

Potato: 15 Tk/kg and Brinjal: 20 Tk/kg

4. CONCLUSION

From the result indicated that cultivation of potato with brinjal at potato (60 cm × 25 cm) + brinjal (120 cm × 75 cm), Potato (50 cm × 20 cm) + Brinjal (100 cm × 70 cm), Potato (50 cm × 20 cm) + Brinjal (100 cm × 75 cm) might be agronomically feasible and economically profitable for potato and brinjal intercropping system as compared to sole treatment. Potato (50 cm × 20 cm) + Brinjal (100 cm × 70 cm) best performed in gross return, gross margin.

REFERENCES

[1] Anowar, M., Parveen, A., Ferdous, Z., Kafi, A.H., Kabir, M.E. 2015. Baseline survey for farmer livelihood improvement at farming system research and development, Lahirirhat, Rangpur. International Journal of Business, Management and Social Research, 2, 92–104.

[2] Anwar, M., Ferdous, Z., Sarker, M.A., Hasan, A.K., Akhter, M.B., Zaman, M.A.U., Haque, Z., Ullah, H. 2017. Employment generation, increasing productivity and improving food security through farming systems technologies in the Monga Regions of Bangladesh. Annual Research & Review in Biology, 16(6), 1-15. DOI: 10.9734/ARRB/2017/35645

[3] Ahmed, N.U., Ferdous, Z., Mahmud, N.U., Hossain, A., Zaman, M.A.U. 2017a. Effect of split application of nitrogen fertilizer on the yield and quality of potato (*Solanum tuberosum*). International Journal of Natural and Social Sciences, 4(2), 60–66.

[4] Bangladesh Bureau of Statistics (BBS). 2016. Yearbook of Agricultural Statistics.

[5] Sullivan, P. 2000. Intercropping Principles and Production Practices. Agronomy Systems Guide. Appropriate technology transfer for rural areas, http://www.attra.ncat.org/attra-pub/intercrop.html. 09/06/03.

[6] Samsuzzaman, S.M., Ali, A., Malik, M.D., Karim, A.S., Khan, M.R., Islam, M.N. 1999. Effect of Intercropping maize population with tomato on their productivity and profitability in the farmers field. Bangladesh Journal.

[7] Beyenesh, Z. 2008. Effect of variety and plant population density on yield and yield components of barley and wheat mixed cropping (Hanfets) in Tigray, Ethiopia. M.Sc. Thesis, Mekelle University, College of Dryland Agriculture and Natural Resources, Mekelle, Ethiopia.

[8] Sharaiha, R., Battikhi, A. 2002. A study on Potato- Corn intercropping microclimate modification and yield advantages. Agricultural Sciences, 2, 97-108.

[9] FAP 16/19. 1993a. Charland Study Overview: Summary Report, Flood Plain Coordination Organization, Ministry of Irrigation Water Development and Flood Control, Dhaka.

[10] Rahman, J., Talukder, A.H.M.M.R., Nahar, L., Rahman, M.M., Kayser, N. 2015. International Journal of Applied Research, 1(2), 79-82.

[11] Talukder, A.H.M.M.R., Rahman, J., Nahar, L., Rahman, M.M., Kayser, N. 2015. Mixed cropping onion with different plant population of sweet gourd. IOSR Journal of Agriculture and Veterinary Science, 45-50.

[12] Talukder, A.H.M.M.R., Rahman, J., Rahman, M.M., Biswas, M., Asaduzzaman, M. 2015. Optimum ratio of coriander intercropping with onion. International Journal of Plant & Soil Science, 4(4), 404-410.

[13] Bangladesh Bureau of Statistics (BBS). 2011. District Statistics, Jamalpur.

[14] UNDP – FAO. 1988. Land resources appraisal of Bangladesh for agricultural development. Report to Agro-ecological regions of Bangladesh. UNDP- FAO, BGD/81/ 035 Technical Report, 2, 570.

[15] FRG. 2012. Fertilizer Recommendation Guide, Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka, 1215, 274.

[16] Aujeneyulu, V.R., Singh, S.P., Ali, M. 1982. Effect of competition free period technique and pattern pearl millet planting in growth and yield of mungbean and total productivity in solid pearl millet and pearl millet mungbean intercropping system. Indian Journal of Agronomy, 27, 219-226.

[17] Mead, R., Willey, R.W. 1980. The concept of land equivalent ratio and Advantages in yields from intercropping. Experimental Agriculture, 16, 217-228.

[18] Willey, R.W., Osiru, D.S.O. 1972. Studies on mixtures of maize and beans (Phaseolus vulgaris) with particular reference to plant population. Journal of Agricultural Science, 79, 517-529.

[19] Amini, B.A., Mazaheri, D. 1996. The Effect of plant density of Maize-Potato in Sole Cropping and Intercropping. Fifth Iranian Congress on Crop Production and Breeding. Karaj.

[20] Tesfay, A., Yigzaw, D., Ermias, A. 2006. Review of Potato and Sweet Potato variety Development and Agronomic Research Achievements in Northern Ethiopia In Proceedings of the Inaugural & First Ethiopian Horticultural Science Society Conference, Addis Ababa, Ethiopia.

[21] Motiur, A.H.M., Talukder, R., Ahmed, B., Nahar, L., Hossain, K.M.F., Rahman, J., Paul, S.K. 2016. Enhancement of farm productivity through intercropping of vegetables, pulse and oilseed crops with wheat at Jamuna Char area of Islampur in Jamalpur District. International Journal of Applied Research, 2(2), 71-76.

[22] Ahmed, F., M.A. Rahman, M.A.H.S. Jaahn, M. Ahmed and M.A. Khayer. 2006. Effect of different planting system in maize/spinach-red amaranth intercropping. Bangladesh J. Agric and Environ. 2(2): 69-79

[23] Awal, M.A., Kothi, H., Ikeda, T. 2006. Radiation interception and use by maize/peanut intercrop canopy. Agricultural and Forest Meteorology, 139, 73-84.

[24] Francis, C.A. 1986. Multiple cropping systems. Macmillan Publ. Co, New York, 383.

[25] Gardiner, T.R., Craker, L.E. 1981. Bean growth and light interception in maize-bean intercrop. Field Crops Research, 4, 313-320.

[26] Hiebsch, C.K. 1980. Principles of intercropping: Effects of N fertilization, plant population and crop duration on equivalent ratios in intercrop versus monoculture. Ph.D. dissert. North Carolina State University. Raleigh, 413, 4337.

[27] Islam, M.N. 2002. Competitive interference and productivity in maize-bushbean intercropping system. A Ph D. Dissertation, Dept. of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur.

[28] Javanmard, A., Mohamadi Nasab, A.D., Javanshir, A., Moghaddam, M., Janmohammadi, H. 2009. Forage yield and quality in intercropping maize with different legumes as double-cropped. Journal of Food Agriculture and Environment, 7, 163-166.

[29] Li, L., Sun, J., Zhang, F., Li, X., Yang, S., Rengel, Z. 2001. Wheat/maize or wheat/soybean strip intercropping I. Yield advantage and interspecific interactions on nutrients. Field Crops Research, 71, 123-137.

[30] Myaka, F.A. 1995. Effect of time of planting and planting pattern of different cowpea cultivars on yield of intercropped cowpea and maize in tropical sub-humid environment. Tropical Science, 35, 274-279.

[31] Ofori, F., Stern, W.R. 1987. Cereal-legume intercropping systems. Advances in Agronomy, 41, 41-90.

[32] Prabhakar, B.S., Shukla, V. 1990. Crop land use efficiency in sequential intercropping systems with vegetables. Indian Journal of Horticulture, 47, 427-430.

[33] Reddy, M.S., Willey, R.W. 1981. Growth and resource use studies in an intercrop of pearl millet/groundnut. Field Crops Research, 4, 13-24.

[34] Reedy, T.Y., Reddi, G.H.S. 1992. Principles of Agronomy, kalyanim publishers. New Delhi-110002. India, 423.

[35] *Pal, S. 2012.* "Jamalpur District". *In Sirajul Islam and Ahmed A. Jamal. Banglapedia: National Encyclopedia of Bangladesh (Second ed.).* Asiatic Society of Bangladesh.

[36] Santalla, M., Rodino, A.P., Casquero, P.A., De Ron, A.M. 2001. Interactions of bush bean intercropped with field and sweet maize. European Journal of Agronomy, 15, 185-196.

[37] Sheehan, W. 1986. Response of specialist and naturalist natural enemies to agroecosystem diversification. A selective review. Environmental Entomology, 15, 456-461.

[38] Tsegay, A., Vanuytrecht, E., Abrha, B., Deckers, J., Gebrehiwot, K., Raes, D. 2015. Sowing and irrigation strategies for improving rainfed tef (Eragrostistef (Zucc.) Trotter) production in the water scarce Tigray region, Ethiopia. Agricultural Water Management,150, 81-91.

[39] Vandermeer, J. 1989. The ecology of intercropping. Cambridge University Press, Great Britain, 237.

[40] Vandermer, J.H. 1989. The ecology of intercropping. Cambridge: Cambridge University Press.

[41] Vohra, S., Rizaman, B., Khan, J.A. 1994. Medical uses of common Indian vegetables. Planta medea, 23, 381-393.