International Journal of Plant & Soil Science
5(6): 366-374, 2015; Article no.IJPSS.2015.089
ISSN: 2320-7035

SCIENCEDOMAIN *international*
www.sciencedomain.org

Evaluation of Efficiency of Baby Corn Based Vegetable Intercropping Systems

S. Adhikary[1*], A. V. V. Koundinya[2], M. K. Pandit[2] and B. Bhattacharya[3]

[1]Agricultural and Ecological Research Unit, Indian Statistical Institute, Kolkata, India.
[2]Department of Vegetable Crops, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, India.
[3]District Seed Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, India.

Authors' contribution

This work was carried out in collaboration between all authors having equal contribution in all aspects of the field trial and preparing this article. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2015/14914
Editor(s):
(1) Sławomir Borek, Faculty of Biology, Department of Plant Physiology, Adam Mickiewicz University, Poland.
(2) Francisco Cruz-Sosa, Biotechnology Department, Metropolitan Autonomous University Iztapalapa Campus, Av. San Rafael Atlixco 186 México City 09340 México.
Reviewers:
(1) Anonymous, Egypt.
(2) Changbing Yu, Oil Crops Research Institute of Chinese Academic of Agricultural Science, China.
(3) Anonymous, Canada.
(4) Anonymous, USA.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=784&id=24&aid=7876

Original Research Article

Received 28th October 2014
Accepted 3rd January 2015
Published 26th January 2015

ABSTRACT

Aims: Experiment was conducted with the objectives to study the productivity, profitability and competition indices of intercropping systems and also to study the difference in progress of yellow vein mosaic virus in okra in sole and intercropping systems.
Study Design: Randomized Block Design with Four replications.
Place and Duration: The experiment was conducted in lower Gangetic alluvial zone of India at District Seed Farm (A-B Block), Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal during spring-summer season, 2013 and 2014.
Methodology: To achieve the objectives, in this experiment baby corn was taken as the base crop and it was intercropped with vegetables like cowpea, chilli, brinjal and okra.
Results: Significantly highest Baby corn Equivalent Yield (BEY) was exhibited by baby corn + cowpea (150.8 q ha^{-1}) followed by baby corn + okra (122.6 q ha^{-1}) and baby corn + brinjal (120.9 q ha^{-1}). Also significantly highest Benefit: Cost (B:C) ratio was observed in baby corn + cowpea (3.34) intercropping followed by baby corn + okra (3.29), baby corn + brinjal (3.28) and baby corn + chilli

**Corresponding author: E-mail: drsujitadhikary@yahoo.com;*

(3.15). All the intercrop treatments recorded Land Equivalent Ratio (LER) values more than 1 and highest LER value was observed for baby corn + cowpea (1.60) system. Highest Monetary Advantage Index (MAI) was also found for baby corn + cowpea (37833.5) intercropping system stating that it was the most profitable among all the intercropping treatments. The total Relative Crowding Coefficient (K_t) values ranged from 2.36-12.80 suggesting yield advantage through intercropping. Positive Aggressivity values of baby corn (A_b) were showing that baby corn dominated the vegetable intercrops. Higher Competitive Ratio for baby corn (CR_b) values (4.12-6.75) than Competitive Ratio for vegetables (CR_v) (0.15-0.27) indicated the higher competitive ability of the baby corn for resources than vegetable intercrops. In okra, the lesser Yellow Vein Mosaic Virus (YVMV) incidence and slow progress in disease at 30 and 60 DAS were observed in intercropping situation than sole cropped okra. Conclusion: Summing up all, the study indicated that baby corn based vegetable intercropping systems were productive and profitable than sole cropping and also baby corn acts as barrier to the movement of whitefly, aphids etc.

Keywords: Baby corn; vegetables; intercropping; productivity; competition indices; YVMV progress.

1. INTRODUCTION

Albeit India is the second largest producer of vegetables in the world next to China, the per capita availability of vegetables in the country is much lower than the per capita requirement. This demands further increase in the vegetable production. Ever increasing population and decrease in cultivable land are the general constraints to it, but, now a day changes in climate added another constrains like crop failures, shortage of yields, reduction in quality and increasing pest and disease problems [1]. Under such circumstances, intercropping of vegetables can be a possible and reliable measure to cope up with these problems as it is a more productive system and a less risky technology [2]. It is productive through judicious utilization of resources viz., light, space, water and nutrients and in stress prone areas, especially in south Asia and Africa where environmental stresses are common [3] it avoids risk as failure in one crop can be compensated from the yield of another crop. Intercropping also helps in reducing the spreading of diseases by preventing contact or acting as barrier to the insect vectors of viral diseases, when two contrasting crops in terms of diseases are grown together. Moreover, intercropping with legumes is a key component in nutrient management [4] in organic farming, where fossil fuel based and synthetic chemicals are not allowed [3].

Baby corn is best suitable for intercropping system as it is a short duration crop, requires limited space due to single stem upright growing habit rather than spreading and thereby better sunlight and aeration are available to the companion crops. Baby corn (*Zea mays var. rugosa*) is a commercial crop that fetches high return to the farmers and gaining importance among farming community for past few years.

In the above context, present experiment was conducted with the objectives to study the system productivity, profitability and competition indices of intercropping systems and also to study the difference in progress of yellow vein mosaic virus in okra in mono and intercropping systems. To achieve the objectives, in this experiment baby corn was taken as the base crop and it was intercropped with vegetables like cowpea, chilli, brinjal and okra.

2. MATERIALS AND METHODS

The present experiment was carried out at District Seed Farm (A-B Block), Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal during and spring-summer season, 2013 and 2014 in Randomized Block Design with four replications. In general the soil nutrients of the experimental plot were: Total N (6.06%), Available P (18.47 kg ha^{-1}), Available K (127.22 kg ha^{-1}) and Organic Carbon (0.63%). The experimental site is belong in lower Gangetic Alluvial Zone of India and climate is humid subtropical having annual rainfall 1300-1500 mm. Treatments include both sole cropping of all crops and their respective intercrop with baby corn. Baby corn was grown at 60 X 20 cm spacing in case of sole crop whereas in intercropping system it was grown at 30 X 20 cm spacing in paired rows. The space between two paired rows was 180 cm. Cowpea, brinjal, and okra were grown at 30 X 10, 60 X 60 and 45 X 30 cm respectively, in both sole and intercropping system. Chilli was grown at 60 X 30 cm spacing as sole crop and 45 X 30 cm spacing as intercrop. Therefore, the row number in

intercropping treatments was as follows, cowpea (5), brinjal (2), chilli (3) and okra (3). Seeds of baby corn, cowpea and okra were dibbled @ the rate of 2-3 seeds/hole and seedlings of brinjal and chilli were transplanted at 30 DAS. Organic manure (vermicompost) @ 50 q ha^{-1} was applied at the time of land preparation. Chemical fertilizer as basal dose @ 20:60:40 kg ha^{-1} ($N:P_2O_5:K_2O$) was applied at the time of sowing and 20 kg N ha^{-1} was applied as top dressing at knee-high stage of baby corn. Standard cultural practices were followed and irrigation was given as per requirement. The most important operation in baby corn production technology is the avoidance of pollination. If the silk is pollinated, the kernels start developing within hours and the cob becomes hard [5]. Therefore, detasseling was done as soon as the tassels appeared. The market value of the crops per kilo gram used in calculating the profitability indices was as follows: baby corn- 80 INR, cowpea- 15 INR, chilli- 40 INR, brinjal- 40 INR and okra- 30 INR.

Yield data were collected from whole plot and converted into hectare to determine the production and subjected to calculate different competition indices for system productivity evaluation. To examine the intercropping advantage or disadvantage over sole cropping and best found intercropping system different competition indices and competition functions were calculated using the following calculating procedure:

1. Baby corn equivalent yield (BEY) was calculated by considering prices of both the crops with the following formula given as [6]:

$$\text{BEY (Kg/ha)} = \text{Baby corn yield (Kg/ha)} + \frac{\text{Inter crop yield (Kg/ha) X price (Rs./Kg)}}{\text{Maize price (Rs./Kg)}}$$

2. Land equivalent ratio (LER) was calculated [7] as per:

   $LER = (LER_b + LER_v)$,

   where $LER_b = (Y_{bv} / Y_b)$, and $LER_v = Y_{vb} / Y_v$, where Y_b and Y_v are the yields of baby corn and vegetables as sole crops, respectively, and Y_{bv} and Y_{vb} are the yields of baby corn and vegetables as intercrops, respectively.

3. Area Time Equivalent Ratio (ATER) was calculated [8] according to the formula:

$$ATER = \frac{(RYb \text{ X } tb) + (RYv \text{ X } tv)}{T}$$

Where, RY = Relative yield of baby corn and vegetables (RY = yield of intercrop per hectare/yield of sole crop per hectare), t = Duration (days) for baby corn and vegetables and T = Total duration (days) of the intercropping system.

LER and ATER indicate the yield advantage per unit area in an intercropping system over sole cropping providing that all other things being equal [9].

4. The Actual Yield Loss (AYL) was calculated [10] as:

   $AYL = AYL_b + AYL_v$,
   Where, $AYL_b = ((Y_{bv} / X_{bv}) / (Y_b / X_b)) - 1$, and $AYL_v = ((Y_{vb} / X_{vb}) / (Y_v / Xv)) - 1$, where X_{bv} and X_{vb} represent the sown proportion of intercrop baby corn with vegetables, and vegetables with baby corn, respectively.

Actual Yield Loss (AYL) is the better index than CR and IA [11]. It is the proportionate yield loss or gain of intercrops when compared with the particular sole crop. Partial actual yield loss also represents the proportionate yield loss or gain of each species grown as intercrops compared to pure stand [12,13].

5. Intercropping Advantage (IA) was calculated using the following formula [11]:

6. $IA_b = AYL_b \text{ X } P_b$
   $IA_v = AYL_v \text{ X } P_v$

   Where, P_b and P_v are the commercial value of baby corn and vegetables respectively

7. The calculation of Monetary Advantage Index (MAI) was calculated as [14]:
   MAI = (value of combined intercrops) (LER-1) /LER

8. The relative crowding coefficient (RCC or K) was calculated as [15]:

   $K = (K_b \text{ X } K_v)$,

Where, $K_b = Y_{bv} \text{ X } Z_{vb} / ((Y_b - Y_{bv}) \text{ X } Z_{bv})$ and $K_v = Y_{vb} \times Z_{bv} / ((Y_v - Y_{vb}) \times Z_{vb})$ where Z_{bv} and Z_{vb} were the proportions of baby corn and vegetables in the mixture, respectively.

Relative crowding coefficient (RCC or K) indicates the relative dominance of one species over the other in intercropping [15]. K value greater than1 indicates a yield advantage and less than 1 indicates disadvantage; whereas K value equals to 1, there is no yield advantage [16].

9. The Aggressivity (A) was calculated as [17]:

$$A_b = (Y_{bv} / Y_b \times Z_{bv}) - (Y_{vb} / Y_v \times Z_{vb})$$
$$A_v = (Y_{vb} / Y_v \times Z_{vb}) - (Y_{bv} / Y_b \times Z_{bv}),$$

10. The Competitive Ratio (CR) index was calculated using the following formula [18]:

$$CR_b = (LER_b / LER_v) (Z_{vb} / Z_{bv}),$$
$$CR_{v\,=} (LER_v / LER_b) (Z_{bv} / Z_{vb})$$

'b' and 'v' denotes baby corn and vegetable, respectively in all cases of this article.

To study the progress in Yellow Vein Mosaic Virus (YVMV) disease in okra, observations like no. of infected leaves per plant and percentage of infected leaves per plant were collected on five randomly selected plants and percentage of infected plants was calculated on whole plot basis.

3. RESULTS AND DISCUSSION

3.1 Productivity and Profitability

Baby corn Equivalent Yield and Benefit: Cost ratio of intercropping system were presented in Table 1. All the intercropping treatments except baby corn + chilli (93.5 q ha^{-1}) produced higher BEY than sole baby corn (115 q ha^{-1}). Significantly highest BEY was exhibited by baby corn + cowpea (150.8 q ha^{-1}) followed by baby corn + okra (122.6 q ha^{-1}) and baby corn + brinjal (120.9 q ha^{-1}) proving the more productivity of intercropping over sole cropping. Higher BEY values for baby corn + cowpea intercropping system was previously reported [5,19]. Significantly highest B:C ratio was observed in baby corn + cowpea (3.34) intercropping followed by baby corn + okra (3.29), baby corn + brinjal (3.28) and baby corn + chilli (3.15). Higher B:C ratios were exhibited by intercropping treatments than that of sole cropping treatments [4]. Also [5,20] higher B:C ratio for baby corn + cowpea intercropping system was supported.

LER and ATER values were presented in Table 2. All the intercrop treatments recorded LER values more than 1 depicting the yield advantage in intercropping over sole cropping. Among all the intercropping treatments highest LER value was observed for baby corn + cowpea (1.60) i.e. 60% more area was required to produce same combined yield as in intercropping system when these two crops are grown separately. This was followed by baby corn + chilli (1.56) and baby corn + okra (1.41). Lowest LER value was observed for baby corn + brinjal (1.20) intercropping system. It was previously [21] observed higher LER values for maize + legume (beans) intercropping system than maize + tomato and maize + tuber crops. LER value of 0.82 was observed [22] for maize + okra intercropping. Highest ATER value was observed for baby corn + chilli (2.25) showing an advantage of 125% followed by baby corn + cowpea (1.69), baby corn + brinjal (1.61) and baby corn + okra (1.58) showed an advantage of 69%, 61% and 58% respectively, over sole cropping. Area time equivalent ratio provides more realistic comparison of the yield advantage of intercropping over monocropping in terms of time taken by component crops in the intercropping systems [13].

Table 1. Baby corn equivalent yield and benefit: cost ratio of baby corn based vegetable intercropping system

Treatments	BEY (Q ha^{-1})	B:C ratio
Baby corn sole	115.0	3.09
Cowpea sole	106.9	2.42
Brinjal sole	81.2	2.35
Chilli sole	11.0	1.13
Okra sole	69.6	1.88
Baby corn +Cowpea	150.8	3.34
Baby corn +Brinjal	120.9	3.28
Baby corn +Chilli	93.5	3.15
Baby corn +Okra	122.6	3.29
S.E (m)	15.35	0.34
C.D (p=0.05)	46.4	1.04

AYL, IA and MAI of intercropping system were presented in Table 3. Highest reduction of 158% in yield was observed for okra followed by 41% for brinjal, 27% for cowpea and 19% for chilli when intercropped with baby corn. However, positive values the total AYL_t values gave a picture of gain in combined yield of components in intercropping system when compared to the sole crops of components. Baby corn + chilli intercropping system had highest gain in yield (290%) followed by baby corn + cowpea (277%), baby corn + brinjal (250%), baby corn + okra (143%). Positive AYL_b values were a sign of gain

in yield in baby corn when compared with sole baby corn. Negative AYL_v values of vegetables were a sign of reduction or loss in the yields of intercrops when compared with sole crops. Likewise positive AYL_t values were observed for maize + cowpea intercropping system [16]. Intercropping Advantage (IA) is another index, which indicates proportionate loss or gain of intercrops in terms of money when compared with the particular sole crop. The positive IA_b values were suggesting an advantage for baby corn whereas negative IA_v values were advocating disadvantage for vegetable intercrops. The positive values of total IA (IA_t) were meant that there was an advantage in intercropping than sole cropping and the baby corn component compensated the loss in vegetable component. Monetary Advantage Index (MAI) is the real index that gives information on economic advantage of intercropping system as it utilizes LER values besides economic value of crops. Highest MAI was found for baby corn + cowpea (37833.5) intercropping system stating that it was the more profitable among all intercropping treatments and it was also evidenced by B:C ratio analysis. This higher MAI was probably due to higher LER, RCC and CR [14]. This was followed by baby corn + chilli (26172.9), baby corn + okra (25080.1). Baby corn + brinjal was proved to be the least profitable in comparison to other intercropping systems with a low (15853.8) MAI value. Higher MAI values for maize + legume intercropping were previously studied by [14,16].

3.2 Competition Indices

RCC, Aggressivity and CR of intercropping system were presented in Table 4. The partial (K_b) values of bay corn (11.39-19.12) were greater than 1 indicating an advantage in yield for baby corn. But, the partial K_v values of vegetables (0.21-0.99) were less than 1 depicting a disadvantage or potential reduction in yield when compared to sole cropping. However, the total K_t values were greater than one for all the intercropping systems (2.36-12.80) signifying yield advantage of intercropping systems over sole cropping. It further indicated that baby corn was more competitive than vegetables and intercropping with vegetables did not have any negative effect on baby corn. Similar results were observed for maize when grown with cowpea [23]. Aggressivity (A) is often used to determine the competitive relationship between two crops used in the mixed cropping [16]. The positive aggressivity values of baby corn (A_b) and negative aggressivity values of vegetables were showing that baby corn dominated the vegetable intercrops among all the intercropping systems. Moreover, the lesser numerical values of aggressivity indicated that there was no greater difference between actual and expected yields. Competitive ratio (CR) is also a measure of competitive ability of the component crops in an intercropping system and is also a better index as compared with RCC and aggressivity [18]. CR also followed the similar trend like A. Higher CR_b values (4.12-6.75) than CR_v (0.15-0.27) pointed out the higher competitive ability of the baby corn for resources than vegetable intercrops. This might be the reason for considerable yield reduction in intercrops when compared to respective sole crops which was specified by the lower K_v values (<1). [16,23] also found complete dominance of maize over cowpea and also reported that maize was more competitive than cowpea and beans.

3.3 Progress of YVMV of Okra in Sole and Intercropping Systems

Observations on percentage of YVMV infected plants, no. of infected leaves per plant and percentage of infected leaves per plant were recorded on okra plants at 30, 60 and 90 DAS in both sole and intercropping system to study the disease progress in both the systems. The data were presented in the form of graphs in Figs. 1, 2 and 3. The gap between percentages of YVMV infected plants in both systems was more at 30 DAS (51.44%, 36.27%) and it was gradually reduced by the time of 60 DAS (79.79%, 72.77%), which became almost similar at 90 DAS (94.46%, 91.03%) showing that infestation was less in initial stages in intercropping system (Fig. 1).

Table 2. Land equivalent ratio (LER) and area time equivalent ratio (ATER) of baby corn based vegetable intercropping system

Treatments	LER	ATER
Baby corn +Cowpea	1.60	1.69
Baby corn +Brinjal	1.20	1.61
Baby corn +Chilli	1.56	2.25
Baby corn +Okra	1.41	1.58

Observations on number of infected leaves per plant and percentage of infected leaves per plant (Figs. 2 and 3) also showed less incidence of disease in intercropping system at 30 DAS than sole crop and the gap was maintained up to 60 DAS, but the gap was much narrowed by the

time of 90 DAS. This could be due to removal of baby corn plants after 75 days of sowing, which permitted the free movement of white flies (*Bemisia tabaci*), the vectors of disease. The less disease incidence at 30 and 60 DAS in intercropping situation was due to the restricted movement of white flies as baby corn plants acted as a barrier to them.

In an experiment [24] reported, the maize and cowpea intercrops reduced the final incidence of Cassava Mosaic Disease in the cassava. The effect of intercrops viz., ground nut, sorghum and pearl millet with blackgram on different insect pests was studied in Tamil Nadu, India by [25] and their results revealed that the sucking pests *B. tabaci* and *E. kerri* population was low in the intercropped blackgram when compared to sole crop. Presence of sucking pests whitefly *Bemisia tabaci* and leaf hopper *Empoasca kerri* was high in sole blackgram crop than intercropped plots. *B. tabaci* population was 1.55 plant^{-1} in sorghum intercropped blackgram plants at 1:3 ratio during 2010. In pure crop the population was 3.65 plant^{-1}. Several workers had found the better control of whitefly through intercropping than sole cropping. It was reported [26] that cassava intercropped with cowpea supported 46% fewer whiteflies per leaf and 70% fewer per plant than cassava monocultures. Border cropping system in okra with maize, sorghum, pigeonpea and pearl millet revealed that maize border plots recorded highest number of parasitoids on aphids of okra [27].

Table 3. The actual yield loss (AYL), intercropping advantage (IA) and monetary advantage index (MAI) of baby corn based vegetable intercropping system

Treatments	AYL			IA			MAI
	AYL_b	AYL_v	AYL_t	IA_b	IA_v	IA_t	
Baby corn +Cowpea	3.04	-0.27	2.77	24357.8	-406.3	23951.5	37833.5
Baby corn +Brinjal	2.91	-0.41	2.50	23292.1	-1634.0	21658.1	15853.8
Baby corn +Chilli	3.09	-0.19	2.90	24737.3	-757.8	23979.5	26172.9
Baby corn +Okra	3.01	-1.58	1.43	24102.4	-4752.5	19349.9	25080.1

Table 4. Relative crowding coefficient (RCC), aggressivity (A) and competitive ratio (CR) of baby corn based vegetable intercropping system

Treatments	RCC			Aggressivity		CR	
	K_b	K_v	K_t	A_b	A_v	CR_b	CR_v
Baby corn +Cowpea	13.34	0.54	7.50	0.0332	-0.0332	5.66	0.27
Baby corn +Brinjal	11.39	0.21	2.36	0.0332	-0.0332	6.75	0.15
Baby corn +Chilli	19.12	0.49	6.89	0.0328	-0.0328	4.12	0.24
Baby corn +Okra	14.17	0.99	12.80	0.0318	-0.0318	5.79	0.21

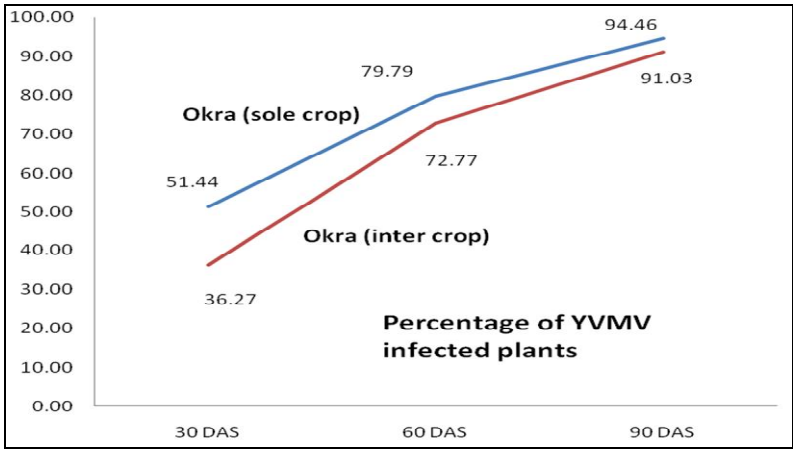

Fig. 1. Percentage of yellow vein mosaic virus infected okra plants in the baby corn based vegetable intercropping system at different days after sowing (DAS)

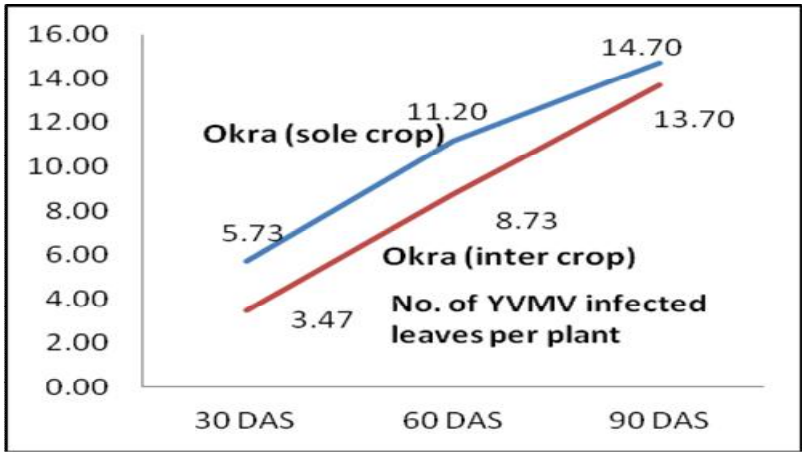

Fig. 2. No. of yellow vein mosaic virus infected okra leaves per plant in the baby corn based vegetable intercropping system at different days after sowing (DAS)

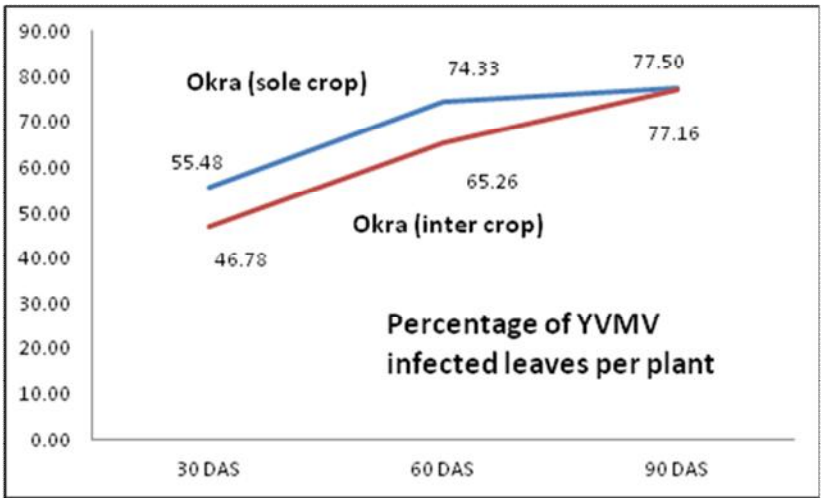

Fig. 3. Percentage of yellow vein mosaic virus infected okra leaves per plant in the baby corn based vegetable intercropping system at different days after sowing (DAS)

4. CONCLUSION

Among all the intercropping treatments baby corn + cowpea intercropping system was found to be as the most productive and profitable cropping system than other systems as it had the highest BEY, B:C ratio and MAI. Baby corn was found to be dominant and more competitive than the vegetables. This could be proved by high K_b, CR_b values. All the vegetable intercrops were less competitive than baby corn and had almost similar competitive ability. Though productivity of vegetables was reduced with intercropping, the loss in yield was compensated by the gain in yield of baby corn. Lesser initial incidence of YVMV was observed in baby corn + okra intercropping than okra sole cropping and the disease progress was also slow in intercropping system than sole cropping. So, it could be concluded that baby corn based vegetable intercropping systems were productive and profitable than sole cropping and such systems may be playing prominent role in future, especially under changing climatic scenario and also baby corn acts as barrier to the movement of whitefly, aphids etc.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Koundinya A, Sidhya P, Pandit MK. Impact of climate change on vegetable cultivation-A review. International Journal of Agriculture, Environment & Biotechnology. 2014;7(1):145-155.
2. Kamanga BC, Waddington GSR, Robertson MJ, Giller KE. Risk analysis of maize-legume crop combinations with small holder farmers varying in resource endowment in central Malawi. Journal of Experimental Agriculture. 2010;46:1-21.
3. Machado S. Does intercropping have a role in modern agriculture? Journal of Soil and Water Conservation. 2009;64(2):55-57.
4. Adhikary S, Chakraborty T, Bagchi DK. Bio-economic evaluation of maize (*Zea mays*) and groundnut (*Arachis hypogaea*) intercropping in drought-prone areas of Chotonagpur plateau region of Jharkhand. Indian Journal of Agronomy. 2005;50(2): 113-115.
5. Reddy VB, Madhavi GB, Reddy VC, Reddy KG, Reddy MCS. Intercropping of baby corn (*zea mays l.*) with legumes and cover crops. Agric. Sci. Digest. 2009;29(4):260-263.
6. Verma SP, Modgal SC. Production potential and economics of fertilizer application as resource constraints in maize-wheat crop sequence. Himachal J. Agric. Res. 1983;9:89-92.
7. Willey RW. Intercropping its importance and research needs, Part-I, Competition and yield advantages. Field Crop Abstracts. 1979;32:1-10.
8. Hiebsch CK, Macollam RE. Area time equivalency ratio. A method for evaluating the productivity of intercrops. Agronomy Journal. 1980;75:15-22.
9. Dariush M, Ahad M, Meysam O. Assessing the land equivalent ratio (LER) of two corn (*Zea mays* L.) varieties intercropping at various nitrogen levels in Karaj, Iran. Journal of Central European Agriculture. 2006;7(2):359-364.
10. Banik P. Evaluation of wheat (*T. aestivum*) and legume intercropping under 1:1 and 2:1 row-replacement series system. J. Agron. Crop Sci. 1996;176:289-294.
11. Banik P, Sasmal T, Ghosal PK, Bagchi DK. Evaluation of Mustard (*Brassica compestris* var. Toria) and legume intercropping under 1:1 and 2:1 row-replacement series systems. J. Agron. Crop Sci. 2000;185:9-14.
12. Dhima KV, Lithourgidis AA, Vasilakoglou IB, Dordas CA. Competition indices of common vetch and cereal intercrops in two seeding ratio. Field Crop Res. 2007;100:249-256.
13. Aasim M, Umer EM, Karim A. Yield and Competition Indices of Intercropping Cotton (*Gossypium hirsutum* L.) Using Different Planting Patterns. Tarim Bilimleri Dergisi. 2008;14(4):326-333.
14. Ghosh PK. Growth, yield, competition and economics of groundnut/cereal fodder intercropping under various row proportions. Indian Journal of Agronomy. 2004;53(2):121-124.
15. De Wit CT. On competition. Verslag Landbouwkundige Onderzock.1960;66:1-82.
16. Yilmaz S, Atak M, Erayman M. Identification of advantages of maize-legume intercropping over Solitary cropping through competition indices in the east mediterranean region. Turk J Agric. 2008;32:111-119.
17. McGilchrist CA. Analysis of competition experiments. Biometrics. 1965;21:975-985.
18. Willey RW, Rao MR. A competitive ratio for quantifying competition between intercrops. Exp. Agric.1980;16:117-125.
19. Kumar TK, Venkateswarlu B. Baby corn (*Zea mays L.*) performance as vegetable-cum-fodder in intercropping with legume fodders under different planting patterns. Range Mgmt. & Agroforestry. 2013;34(1): 137-141.
20. Nataraj KD, Kalyana Murthy KN, Viswanath AP. Economics of baby corn cultivation under sole and intercropped situation with leguminous vegetables. Agric. Sci. Digest. 2011;31(3):211-213.
21. Sangakkara R, Bandaranayake S, Attanayake U, Stamp P. Impact of associated intercrops on growth and yield of maize (*Zea mays L*) in major seasons of south Asia. Maydica Electronic Publication. 2012;57:6-10.
22. Alabi RA, Esobhawan AO. Relative economic value of maize – okra intercrops in rainforest zone, Nigeria. Journal of central European agriculture. 2006;7(3): 433-438.
23. Sharma RP, Singh AK, Poddar BK, Raman KR. Forage production potential and economics of maize (*Zea mays*) with legumes intercropping systems in the

semi-arid tropics of India. Field Crops Res. 2008;88:227-237.

24. Fondong VN, Thresh JM, JMS, Zok S. Spatial and temporal spread of cassava mosaic virus disease in cassava grown alone and when intercropped with maize and/or cowpea. Journal of Phytopathology. 2002;150(7):365-374.
25. Soundararajan RP, Chitra N. Impact of intercrops on insect pests of blackgram, *Vigna mungo* L. Journal of Entomology. 2012;9:208-219.
26. Gold CS. The effects of cropping systems on cassava whiteflies in Colombia: Implications for control of African Cassava Mosaic Virus Disease. African Crop Science Journal. 1994;2(4):423-436.
27. Nderitu J, Kasina M, Malenge F. Evaluating border cropping system for management of aphids (*Hemiptera: Aphididae*) infesting Okra (*Malvaceae*) in Kenya. J. Entomology. 2008;5:262-269.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=784&id=24&aid=7876