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# PRODUCTIVITY OF MAIZE (*ZEA MAYS*) *BASED* INTERCROPPING SYSTEM DURING *KHARIF* SEASON UNDER RED AND LATERITIC TRACT OF WEST BENGAL

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**ABSTRACT**
A field experiment was carried out during *kharif* season of 2010 and 2011 at Sriniketan Research Farm, Visva-Bharati, West Bengal. The grain yield and stover yield of maize were significantly higher in case of pure stand of maize than either of its intercropping systems with legumes while the cob yield was highest in the maize with soybean (1:2) intercropping system and it was statistically at par with the yield obtained in sole maize. The grain yield of legume was highest in maize with groundnut intercropping (1:2) and it had highest yield followed by sole groundnut. The maize equivalent yield was highest in maize with soybean intercropping (1:2) followed by maize with groundnut (1:2), maize with groundnut (2:4) and maize with soybean (2:4) intercropping. Thus, under the red and lateritic soil condition where cultivation is practiced with limited water, legume crops like groundnut can be grown as intercrops with maize to get higher monetary returns.

## INTRODUCTION

With rapid increase in population and less chance of bringing new land under cultivation, intercropping seems to be the only way to increase productivity and intensity land use. This situation warrants developing an appropriate technology of growing field crop in association with legumes without too much intercrops interference and competition. Intercropping of cereals with legumes has been popular in tropics (Tsubo *et al.,* 2005) due to its advantages for soil conservation, lodging resistance (Anil *et al.,* 1998), weed control (Banik and Sharma, 2009), yield increment, high crude protein percentage and protein yield ( Kariaga, 2004). Species or cultivar selection, seeding ratios and competition capability within mixtures may affect the growth of the species used in intercropping systems (Kariaga, 2004). Efforts have been made to identify suitable intercropping in maize (*Zea mays* L.) for various agro-climatic zones of West Bengal. Intercropping of maize with legume proved to be more remunerative than growing maize alone. Groundnut (*Arachis hypogaea* L.) and soybean (*Glycine max*) cultivation has assumed a wider scope as a result of their nutritive, economic importance and diverse domestic as well as industrial usage. Apart from improvement and maintenance of soil fertility, intercropping of these legumes is found to be remunerative because under legume and non-legume intercropping situation, legume can fix atmospheric nitrogen which may be available to associated non-legumes. Further both the crops have been found agronomically compatible with other common arable crops. Combinations of groundnut and hybrid maize in intercropping systems may increase the production to fulfill the demand for maize and groundnut. Changing the planting arrangements of the main and component crops is important agronomic approach in intercropping systems but has not been extensively studied. Spatial arrangements of plant, planting rates and maturity dates must be considered when planning intercrops (Ghosh, 2004). Information relating to intercropping of groundnut and soybean in hybrid maize during *kharif* season is inadequate. Hence, the study was conducted in the red and lateritic tract of West Bengal.

## MATERIALS AND METHODS

The field experiment was conducted during two consecutive *kharif* season of 2010 and 2011 at Sriniketan Research Farm (23°39' N latitude, 87°42' E longitude and 58.9 m above mean sea level) of Institute of Agriculture, Visva-Bharati, Birbhum, West Bengal. The area has a typical sub-humid sub-tropical climate with low temperature during winter, hot-dry summer and rainy season. During the period of experimentation the maximum and minimum temperature ranged from 29.9 to 34.7°C and 19.0 to 26.9°C respectively. Crops received total 508.4 and 640.1 mm rainfall distributed during July to November in 2010 and 2011, respectively. The soil of the experimental plot was sandy loam in texture, acidic in reaction (pH 5.5), with low level of organic carbon (0.75 %), available N (210.16 kg/ha) but medium level of available P (24.7 kg/ha) and K (110.20 kg/ha). The experiment was laid

out in a randomized block design with 7 treatments replicated thrice. Treatments comprised of seven cropping situations namely, $T_1$: sole maize, $T_2$: sole groundnut, $T_3$: sole soybean, $T_4$: Maize with groundnut (1:2) ratio, $T_5$: Maize with soybean (1:2) ratio, $T_6$: Maize with groundnut (2:4) ratio and $T_7$: Maize with soybean (2:4) ratio. Under this experiment the main crop was maize var. 'Shakti hybrid' and the intercrops were groundnut var. 'TAG 24' and Soybean var. 'Birsa Soybean1'. Spacing 75 cm × 25 cm in sole maize and for paired row spacing was 50 cm × 25 cm. Intercrops i.e. groundnut and soybean was sown with 25 cm × 10 cm spacing. The fertilizer doses for maize and grain legumes were 150 kg N, 75 kg $P_2O_5$ and 75 kg $K_2O$/ha and 40 kg N, 80 kg $P_2O_5$ and 80 kg $K_2O$/ha respectively. The other management operations were done as per recommended package of practices for both main and intercrops. Growth and yield parameters were recorded as per standard procedures. Available N, P and K in Soil (Jackson, 1973) and N, P and K uptake in plant (Jackson, 1973) samples were analyzed following standard methods. Economics was calculated based on the basis of prevailing market prices of different inputs and outputs. The data analysis of two years data was done separately following randomized block design. Since the error variable was homogenous, instead of year-wise data, pooled values were given for discussion and interpretation.

## RESULTS AND DISCUSSION

### Growth attributes

Maize in pure stand gave comparatively greater plant height than intercropping height situation with legume. Plant height under different intercropping situations showed non-significant differences at harvest (Table 1). Panhwar *et al.* (2004) observed similar observation under maize with soybean intercropping system. Plant height of groundnut did not show significant difference between sole and intercropping situations, while soybean exhibited significantly lower plant height under maize with soybean (2:4) intercropping treatment when compared with sole crop of soybean. But intercropping treatments exhibited non-significant effect on functional leave of maize, although sole crop recorded more number of functional leaves at 60 DAS. Intercropping treatments exerted significant reduction of nodules/plant in groundnut, but had non- significant effect due to difference in row arrangement. While nodules formation in soybean was remain unaffected due to intercropping with maize to that of sole crop of soybean. LAI of maize at 60 DAS was decreased due to intercropping, but there no remarkable difference between the sole and intercrop maize. Similar results were also reported by other researches (Alom *et al.,* 2010 and Oljaca *et al.,* 2000) that had an opinion that sole maize produced higher value than any other intercropping situation. The results also indicated that LAI of both the intercrops (legumes) reduced under intercropping treatments but the effect was non-significant, except one situation where groundnut was intercropped with in 2:4 row arrangements (Table 1). The significantly highest dry matter accumulation of hybrid maize (Var. Shakti hybrid) in monoculture than intercropping treatment. This might be due to better utilization of solar radiation and $CO_2$ as there was no competition with intercrop resulting in better N uptake and less weed infestation (Talukder *et al.,* 2003; Alam *et al.,* 2005; Alom *et al.,* 2010). Sole groundnut produced higher dry matter than any other intercropping treatment. Dry matter accumulation of soybean was significantly reduced in intercropping situation when compared with sole crop, but row arrangement under intercropping did not exhibit significant effect. There was a trend of for higher CGR in sole cropping compared to intercropping due to less competition among the crop components for air and solar radiation Alom *et al.* (2010) also reported similar results. Maize exerted highest CGR in monocropping which was statistically at par maize with soybean (2:4) and maize with groundnut (1:2) intercropping situations. Intercropping treatments exhibited significant effect on CGR of legume intercrops. Groundnut showed significantly higher CGR in monocropping than intercropping, and groundnut at lower density showed greater CGR than higher higher plant stand (Table 1). But plant density under varied row arrangement did not exerted significant effect on CGR of soybean, although sole crop of soybean exhibited significantly higher CGR compared to soybean as an intercrop. Reduction of leaf area and availability of sunlight to underneath of canopy in intercropping situations (Alom *at el.,* 2010) may be the reasons for lower CGR of intercrop (legumes).

### Yield component, yield and quality

The highest weight of dehusked cob/plant was recorded with sole maize which was statically at par with all other intercropping systems except maize with soybean (2:4) intercropping, and it was possibly due to higher plant population, higher inter-row competition and less nutrient

**Table 1: Effect of intercropping system on growth attributes of maize and intercrops (pooled data of 2 years)**

| Treatments | Plant height (cm) at harvest | | Functional leave/plant at 60 DAS | No. of nodule/plant at 75 DAS | LAI at 60 DAS | | DMA ($g/m^2$) at 75 DAS | | CGR ($g/m^2$/day) at 60-75 DAS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Maize | Intercrop | | | Maize | Intercrop | Maize | Intercrop | Maize | Intercrop |
| Sole maize | 162.48 | - | 9.50 | - | 2.69 | - | 447.2 | | 16.76 | - |
| Sole groundnut | - | 56.88 | - | 165 | - | 8.11 | - | 990.4 | - | 22.47 |
| Sole soybean | - | 59.48 | - | 41 | - | 2.62 | - | 419.2 | - | 11.32 |
| Maize + groundnut (1:2) | 154.33 | 54.43 | 8.75 | 143 | 2.69 | 7.97 | 406.7 | 952.8 | 14.02 | 15.97 |
| Maize + soybean (1:2) | 151.85 | 56.75 | 8.50 | 36 | 2.67 | 3.18 | 313.8 | 360.4 | 8.19 | 4.62 |
| Maize + groundnut (2:4) | 154.65 | 54.83 | 8.25 | 145 | 2.37 | 6.46 | 334.1 | 826.4 | 11.19 | 9.52 |
| Maize + soybean (2:4) | 154.03 | 56.23 | 9.00 | 30 | 2.63 | 2.86 | 406.7 | 359.6 | 16.63 | 2.33 |
| SEm ± | 1.79 | 0.97 | 0.52 | 4.56 | 0.12 | 0.119 | 3.67 | 0.85 | 1.33 | 1.90 |
| CD(P=0.05) | 5.50 | 2.93 | NS | 13.75 | NS | 0.360 | 11.31 | 2.56 | 4.10 | 5.72 |

LAI = Leaf area index; DAS = Days after sowing; CGR = Crop growth rate; DMA = Dry matter accumulation

uptake by maize crop (Table 2). In later case the highest number of grains/cob was recorded in maize with soybean (1:2) intercropping system which was statistically at par with sole maize and maize with groundnut (2:4) intercropping treatment. While maize produced lowest number of grain/cob under maize with groundnut (1:2) intercropping system which might be due to the effect of poor length and girth of cob. Intercropping system exhibited non-significant effect on pod weight/plant. The data presented in Table 2 reveled that intercropping treatments exhibited non-significant effect on 1000 seed weight of maize in all plants patterns, although higher test weight was recorded with sole maize. Kalra and Ganger (1980) also reported the higher test weight of maize under pure stand. Test weight of both the intercrops (legumes) was higher under intercropping situation with maize particularly in 2:4 row arrangements and it was closely followed by crops under monocropping. Intercropping showed non-significant effect on the shelling % of maize and so in the case for intercrops also. Thus, the results indicated that the shelling % was not fluctuated under increased population pressure experienced in intercropping system. The results indicate that pod yield of intercrops was not significantly affected by intercropping system. However, slightly higher pod yield was obtained in legume intercrops along as compared to legumes planted as intercrops. Researches (Ghosh, 2002; Sarkar and Pal, 2004; Razzaque *et al.,* 2007) also reported higher pod yield of groundnut in monoculture and it was reduced considerably in intercropping situation. The reduction of pod yield might be due to shading effect of maize on the groundnut (Patra *et al.,* 1990).

Highest grain yield of maize was recorded in monocropping. Intercropping treatments did not cause much reduction of maize grain yield, except situation lick maize with soybean (2:4) intercropping and here the yield reduction was significantly less (Table 2). Among different intercropping situation, maize grain yield was maximum in maize with groundnut (2:4) intercropping treatment. The presence of groundnut in the paired row system probably had more synergistic effect and thereby maize crop in association with groundnut in paired row system reported comparable yield. Intercropping systems reduced the grain yield of the intercropped legumes, and this reduction was non-significant under lower plant density (1:2) and significant under higher plant density (2:4). Yield reductions in intercropping could be associated to inter-specific compaction for nutrients, moisture or space (Adaniyan *et al.,* 2007). Maize shower yield was significantly affected by intercropping pattern. Sole maize treatment produced significantly higher stover yield than all other intercropping treatments. Stover yield of maize was comparative higher when intercropping with soybean than groundnut intercropping and row arrangement exerted non-significant variation in stover yield of maize. Stover yield of intercropped legumes was also significantly affected by intercropping treatments and it was higher in monocropping. Further, stover yield of legumes were reduced much more higher plant density (2:4) than lower plant stand (1:2). The reduction on soybean yields under intercropping with maize has also been reported by several researchers (Muoneke *et al.,* 2007; Egbe, 2010). They shared the same opinion that reduction in soybean yield under intercropping could be due

**Table 2: Effect of intercropping system on yield component, yields and quality of maize and intercrops (pooled data of 2 years)**

| Treatments | Dehusked cob wt./ plant (g) | No. of grain/ cob | Pod wt./ plant (g) | Test weight (g) | | Shelling % | | Pod yield of intercrops (t/ha) | Grain yield (t/ha) | | Stover yield(t/ha) | | Maize eq. yield (t/ha) | Protein content (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Maize | Intercrop | Maize | Intercrop | | Maize | Intercrop | Maize | Intercrop | | Maize | Intercrop |
| Sole maize | 50.28 | 276 | | 235.0 | | 82.26 | - | - | 2.48 | - | 5.70 | - | 2.48 | 9.08 | - |
| Sole groundnut | - | - | 8.07 | - | 415.25 | - | 65.73 | 3.03 | - | 2.02 | - | 3.94 | 2.78 | - | 18.42 |
| Sole soybean | - | - | 5.21 | - | 106.00 | - | 63.62 | 3.27 | - | 2.08 | - | 2.97 | 3.54 | - | 37.06 |
| Maize + groundnut( 1:2) | 45.97 | 235 | 6.88 | 233.3 | 396.75 | 83.38 | 64.99 | 1.44 | 2.06 | 1.93 | 4.72 | 2.82 | 4.71 | 9.14 | 18.32 |
| Maize + soybean (1:2) | 46.18 | 282 | 4.11 | 230.0 | 105.00 | 84.38 | 62.46 | 1.55 | 2.23 | 1.91 | 5.10 | 2.36 | 5.48 | 8.33 | 37.54 |
| Maize + groundnut (2:4) | 47.01 | 266 | 7.57 | 226.8 | 435.50 | 82.79 | 66.72 | 1.26 | 2.26 | 1.88 | 4.59 | 0.97 | 4.85 | 7.66 | 18.52 |
| Maize + soybean (2:4) | 39.26 | 240 | 3.46 | 225.3 | 107.75 | 81.99 | 61.50 | 0.92 | 1.87 | 0.95 | 4.91 | 1.09 | 3.49 | 8.27 | 36.89 |
| SEm ± | 1.89 | 10.1 | 0.47 | 6.07 | - | 1.40 | 1.00 | 1.54 | 0.09 | 0.10 | 0.13 | 0.17 | - | 0.12 | 0.13 |
| CD(p=0.05) | 5.83 | 31.2 | NS | NS | - | NS | 3.03 | NS | 0.28 | 0.30 | 0.31 | 0.50 | - | 0.36 | 0.39 |

**Table 3: Effect of intercropping system on nutrient uptake and post-harvest soil fertility (pooled data of 2 years)**

| Treatments | Organic carbon (%) | Available N ( kg/ha) | Available P ( kg/ha) | Available K ( kg/ha) | N uptake(kg/ha) | | P uptake(kg/ha) | | K uptake(kg/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Maize | Intercrop | Maize | Intercrop | Maize | Intercrop |
| Sole maize | 0.84 | 254.56 | 22.45 | 126.51 | 69.78 | - | 28.35 | - | 74.35 | - |
| Sole groundnut | 0.65 | 155.60 | 20.15 | 115.19 | - | 101.97 | - | 17.39 | - | 25.13 |
| Sole soybean | 0.66 | 137.67 | 20.83 | 132.12 | - | 152.70 | - | 15.37 | - | 30.02 |
| Maize + groundnut (1:2) | 0.81 | 257.03 | 20.60 | 129.29 | 54.10 | 45.73 | 23.10 | 14.57 | 53.29 | 19.20 |
| Maize + soybean (1:2) | 0.82 | 233.97 | 20.19 | 120.94 | 53.10 | 70.60 | 22.64 | 10.78 | 57.74 | 19.35 |
| Maize + groundnut (2:4) | 0.65 | 221.00 | 20.42 | 144.20 | 46.33 | 38.26 | 20.54 | 12.69 | 57.05 | 16.69 |
| Maize + soybean (2:4) | 0.70 | 213.68 | 19.91 | 130.48 | 47.55 | 45.60 | 20.55 | 13.23 | 58.52 | 14.66 |
| SEm ± | 0.03 | 10.11 | 0.68 | 7.49 | 1.84 | 3.47 | 0.66 | 0.59 | 1.40 | 1.30 |
| CD (p = 0.05) | 0.08 | 30.04 | 2.01 | 22.26 | 5.68 | 10.45 | 2.03 | 1.75 | 4.31 | 3.91 |
| Initial status | 0.75 | 210.16 | 24.70 | 110.2 | - | - | - | - | - | - |

to inter-specific competition between the intercrop components for water, light, air and nutrients, and also the aggressive effects on $C_4$ plant (Maize) on $C_3$ plant (Soybean). The shading effect of soybean and groundnut by the maize plant (taller) may also have contributed to reduction on the yield of intercropped legumes by reducing the photosynthetic rate of the lower growing plant (Olufajo, 1992). Lesoing and Francis (1999) supported the above statement with their finding that two water stress and shading contribute to reduce legume component yield under intercropping. All intercropping treatments showed more maize equivalent yield (MEY) than sole maize yield. This result proved the fact that maize with legume intercropping is more profitable then monocropping of maize. Results (Table 2) also showed that even sole cropping of groundnut/soybean exerted higher maize equivalent yield under maize with soybean intercropping (1:2).

Higher value of protein content of sole maize may be attributed to the fact that more uptake of nitrogen by plant might have occurred due to more spacing, less plant population, more root growth etc which was ultimately reflected in higher protein content (Table 2). Protein content of maize was reduced in intercropping treatments, and it was comparatively higher in maize with groundnut intercropping (1:2) which also on par with protein content of maize under monocropping. This might be due to the fact that groundnut produced more number of nodules which trapped N from air and finally reflected in higher protein content. Further, results also showed that under intercropping treatments with low plant density (1:2), maize protein content was comparatively higher their high plant stand (2:4). Irrespective of cropping system, protein of intercrops showed marked variation in protein content, and it was higher in groundnut than soybean. This might be due to fact that groundnut produced more number of nodules which trapped N from air and finally reflected in higher protein content. Further the effect of cropping system on protein content of intercrops was non-significant.

**Nutrient (N, P, and K) uptake**

The total N uptake by sole maize was significantly higher than intercropping systems (Sangakkara *et al.,* 2003). The lowest N uptake was observed in maize + groundnut with higher plant density (2:4) which was statistically at par with maize with soybean intercropping system (2:4). The lowest nitrogen uptake under maize with legume (2:4) intercropping system may be due to higher plant population which might have resulted in less accessibility of available N. The results (Table 3) thus indicated that the monocropping of legumes proved superior over intercropping systems with respect to the N uptake. Soybean was more efficient in utilizing N when compared with groundnut, irrespective of plant density in intercropping system. The P uptake was higher in maize under monocropping, and it was reduced significantly under intercropping treatments. Further, maize plant with legume intercropping showed higher P uptake at low plant density (1:2) than that of higher plant density (2:4). This might be due to the some reason of less inter-crop competition for nutrients under less plant population as compared to higher plant population. Legume showed more P uptake in monocropping and the P uptake was reduced significantly under intercropping situation. Uptake of P was higher in groundnut than soybean both under sole and intercropping situation which proved the fact that groundnut is more efficient in utilizing available P over soybean. Similar to N and P uptake, maize plant under monocropping showed higher K uptake than intercropping situation. Intercrop competition significantly reduced the K uptake by maize plant in intercropping treatments. At higher plant density K uptake by maize was comparatively higher than lower plant population and maize with soybean intercropping (2:4) ratio gave grater K uptake than any other intercropping situations. Soybean was found to be more efficient in utilization K there by uptake of K was more than groundnut under sole cropping. Not much variation was observed in among different intercropping situations.

**Status of post-harvest soil**

The fertility status of the post-harvest soil varied considerably due to cropping systems (Table 3). Maximum increase in soil organic carbon content was recorded in sole maize plots which were statistically at par with the plots where maize intercropped with groundnut/soybean (1:2). OC content of post-harvest was reduced under intercropping situations with higher plant density (2:4). The available N-content showed exactly the similar trend to that of organic carbon content. Available P content was reduced in all the plots when compared with initial P status. Since the experimental soil was acidic (pH 5.5), despite of laving recommended P dose to all the plot, phosphorus might get fixed, ultimately resulting in reduced availability of P, there was a apparent gain in K-content of post-harvest soil in all the plots with respect to initial soil, but difference was non-significant except one plot where maize with groundnut intercropping (2:4). The highest available N in soil was recorded under maize with groundnut intercropping

(1:2) which was statistically at par with the plots of sole maize and maize with soybean (1:2) cropping. The highest available P content was recorder under sole maize which was statistically at par with sole cropping of legumes and maize with legume intercropping systems with closer row ratio (1:2). While maize with legume intercropping system with wider row ratio (2:4) the available P status was low and may be attributed to higher uptake. In case of available K in soil, the highest value was observed under maize with groundnut intercropping (2:4) cropping which were statistically at par with all other plots except sole groundnut and maize with soybean (1:2) intercropping plots. Under legume based intercropping system the available N was increased much more as compared to sole legume treatment and it may be due to fact that in *kharif* season (rainy season) they proved most compatible, economically viable, energetic and superior to their sole planting and to other intercropping systems for getting higher yield and for maintaining higher soil fertility level. The results are in line with the findings of Padhi and Panigrahi (2006).

Maize as sole crop gave reasonable good yield but to sustain soil fertility as well legume intercropping with maize could be the better opinion. Four rows of groundnut in between two paired rows of maize (2:4) would be the best combination for large scale adoption in sub-tropical climatic situation of west Bengal.

## REFFRENCES


**Adaniyan, O. N., Akande, S. R., Balogun, M. O. and Saka, J. O. 2007.** Evaluation of Crop Yield of African Yam Bean, Maize and Kenaf under Intercropping Systems. *American-Eurasian J. Agric. Environ. Sci.* **2(1):** 99-102.

**Alam, M. Z., Haider, S. A. and Paul, N. K. 2005.** Effects of sowing time and nitrogen fertilizer on barley *(Hordeum vulgare L.). Bangladesh J. Bot.* **34(1):** 27-30.

**Alom, M. S., Paul, N. K. and Quayyum, M. A. 2010.** Production potential of different varieties of hybried maize (*Zea mays* L.) with groundnut (*Arachis hypogaea* L.) under intercropping system, *Bangladesh J. Agril. Res.* **35(1):** 51-64

**Anil, L., Park, J., Phlipps, R. H. and Miller, F. A. 1998.** Temperate intercropping of cereals for forage: A review of the potential for growth and utilization with particular reference to the UK. *Grass Forage Sci*. **59:** 301-317.

**Banik, P. and Sharma, R. C. 2009.** Yield and resource utilization efficiency in baby corn-legume-intercropping system in the eastern plateau of India. *J. Sustainable Agric*. **33:** 379-395.

**Egbe, O. M., Alibo, S. E. and Nwueze, I. 2010.** Evaluation of some extra-early and early-maturing cowpea varieties for intercropping with maize in southern Guinea Savanna of Nigeria. *Agric. Biol. J. N. Am.* **1(5):** 845-858.

**Ghosh, P. K. 2004.** Growth and yield competition and economics of groundnut/cereal fodder intercropping system in the semi-arid tropics of India. *Field Crop Res.* **88 (2-3):** 227-237.

**Ghosh, P. K. 2002.** Agronomic and economic evaluation of groundnut (Arachis hypogaea)-cereal fodder intercropping during the post-rainy season. *Indian J. Agron.* **47(4):** 509-513.

**Jackson M. L. 1973.** Soil chemical analysis. Prentice Hall of India Pvt. Ltd; New Delhi.

**Kalra, G. S. and Ganger, B. 1980.** Economics of intercropping of different legumes with maize at different levels of N under rainfed conditions. *Indian J. Agron*. **25:** 181-185.

**Kariaga, B. M. 2004.** Intercropping maize with cowpeas and beans for soil and water management in western Kenya. Proceedings of the 13th international soil conservation organisation conference, July 2004. Conserving soil and water for society, Brisbane. pp. 1-5.

**Lesoing, G. W., Francis, C. A. 1999.** Strip intercropping of grain sorghum/soybean in irrigated and rainfed environments. *J. Prod. Agric.* **12(4):** 601-606.

**Muoneke, C. O., Ogwuche, M. A. O. and Kalu, B. A. 2007.** Effect of maize planting density on the performance of maize/soybean intercropping system in a Guinea Savannah agro-ecosystem. *Afri. J. Agric. Res.* **2(12):** 667-677.

**Oljaca, S., Vetkovi, R. C., Kovacevic, D. Vasic, O. and Momirovic, N. 2000.** Effect of plant arrangement pattern and irrigation on efficiency of maize *(Zea mays* L.) and bean *(Phaseolus vulgaris)* intercropping system. *J. Agric. Sci. Camb*. **135:** 261-270.

**Olufajo, O. O. 1992.** Response of soybean to intercropping with maize in a sub-humid tropical environment. *Trop. Oilseeds J.* **1:** 27-33.

**Padhi, A. K. and Panigrahi, R. K. 2006.** Effect of intercrop and crop geometry on productivity, economics, energetics and soil- fertility status of maize based intercropping systems. *Indian J. Agron.* **51(3):** 174-177.

**Panhwar, M. A., Memon, F. H., Kalhoro, M. A. and Soomor, M. I. 2004**. Performance of maize in intercropping system with soybean under different planting patterns and nitrogen levels. *J. Applied Sci.* **4(2):** 201-204.

**Patra, B. C., Mandal, B. K. and Mandal, B. B. 1990.** Profitability of maize-legume intercropping system. *Indian Agriculturist*. **34(4):** 227-33.

**Razzaque, M. A., Rafiquzzaman, S., Bazzaz, M. M., Ali, M. A. and Talukdar, M. M. R. 2007.** Study on the intercropping groundnut with chilli at different plant populations. *Bangladesh J. Agril. Res.* **32(1):** 37-43.

**Sangakkara, U. R., Richner, W., Schneider, .M. K. and Stamp, P. 2003**. Impact of intercropping beans (*Phaseolus vulgaris* L.) and sunhemp (*Crotalaria juncea* L.) on growth, yields and nitrogen uptake of maize (*Zea mays* L.) grown in the humid tropics during the minor rainy season. *Maydica*. **48(3):** 233-238.

**Sarker, R. K. and Pal, P. K. 2004.** Effect of intercropping rice (*Oryza sativa*) with groundnut (*Arachis hypogaea*) and pigeonpea (*Cajanus cajan*) under different row orientations on rainfed uplands. *Indian J. Agron.* **49(3):** 147-150.

**Talukder, A. S. M. H. M., Sufian, M. A., Meisner, C. A., Duxbury, J. M., Lauren, J. G. and Hossain, A. B. S. 2003.** Rice, wheat and mungbean yields in response to N levels and management under a bed planting system. *Bangladesh J. Ghurpukur Shatkhira*. **5:** 44-48.

**Tsubo, M., Walker, S. and Ogindo, H.O. 2005.** A simulation model of cereal-legume intercropping system for semi-arid regions. *Field Crops Res.* **93:** 23-33.

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