I.J.S.N., VOL. 3(1) 2012: 41-46 ISSN 2229 – 6441

INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

www.scienceandnature.org

PRODUCTION POTENTIAL, SOIL MOISTURE AND TEMPERATURE AS INFLUENCED BY MAIZE- LEGUME INTERCROPPING

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ABSTRACT

A field experiment was conducted on silty loam soil at ICAR Research Complex for NEH Region, Arunachal Pradesh Centre, Basar, India to study the production potential, radiation interception, soil temperature and moisture on maize legumes intercropping during 2009 and 2010. Growth and yield attributes of maize was recorded significantly higher on sole maize but was comparable to 1: 1 and 1: 2 ratios. Similarly, maize grain yields were noted higher under the sole maize. On the other hand intercropping of maize + cowpea at 1: 2 ratio recorded significantly the highest maize equivalent yield (MEY) followed by 1: 5 ratios of same crop combinations. Solar radiation interception (SRI) interception was recorded higher on 1: 5 ratios of maize+ cowpea followed by 1: 5 maize + blackgram intercropping over sole maize. However, the interception was recorded higher on all 1: 5 ratios of crop combinations followed by 1: 2 and 1: 1. Soil temperature was recorded higher on sole maize followed by 1: 1 maize+ frenchbean intercrop. However the lower soil temperature was recorded on 1: 5 maize+ cowpea intercrop. Among the row proportion 1: 5 ratio of intercrop recorded little lower soil temperature followed by 1: 2 and 1: 1 and among the crops cowpea followed by blackgram and frenchbean. In contrary to soil temperature, soil moisture content was recorded higher in 1: 5 maize + cowpea intercrop followed by 1: 5 maize + blackgram intercrop. However, the lowest soil moisture was measured on sole maize.

KEY WORDS: Maize legume intercrop, solar radiation interception, soil temperature and moisture

INTRODUCTION

Sustainable land area for food production in North Eastern Himalayan Region (NEHR) of India remains fixed and many even be decreasing. It is very important to raise crop productivity in order to meet the increasing food requirements of an increasing population. Intercropping, through more effective use of water, nutrients, solar energy and other resources, reduces soil erosion, suppresses weed growth, and thereby significantly enhanced crop productivity compared to the growth of sole crops (John and Mani, 2005; Eskandari and Ghanbari, 2009). Advantages of intercropping have been demonstrated in numerous intercropping systems in the tropics. In recent decades, however, intercropping has also been widely used as one of the techniques for increasing crop yields in different land forms (Li *et al.*, 1999).

To stabilize crop production and to provide insurance mechanism against aberrant weather situations characterizing rainfed agriculture, intercropping could be a viable agronomic means of risk minimizing farmer's profit and subsistence- oriented, energy efficient and sustainable venture (Faroda *et al.*, 2007; Sheoran *et al.*, 2010). Since maize (*Zea mays* L.) is a widely spaced crop, inter row space could profitably by utilized for legumes in the interspaces. Maize-legumes intercropping system, besides increasing productivity and profitability also improves soil health, conserves soil moisture and increases total out turn (Padhi and Panigrahi, 2006; Singh *et al.*, 2008). Spatial arrangement and plant population in an intercropping system have important effects on the balance of competition between component crops and their overall productivity.

Intercropping generate beneficial biological interactions between crops, increasing grain yield and stability, more efficient use of available resources and reducing weed pressure (Kadziuliene *et al.,* 2009). The main principle of better resource use in intercropping is that if crops differ in the way they utilize environmental resources when grown together, they can complement each other and make better combined use of resources than when they grown separately (Ghanbari-Bonjar, 2000). Keeping these things in mind present investigation was carried out to know the growth, yield, solar radiation interception, soil temperature and moisture in maize-legumes based intercropping.

MATERIALS AND METHODS

The field experiment was carried out in silty loam soil at the experimental farm of ICAR Research Complex for NEH Region, Arunachal Pradesh Centre, Basar, located at West Siang District of Arunachal Pradesh, extends 26° 28′ to 27° 95′ N latitude and 94° 76′ E longitude, 631 m above MSL, India during 2009 and 10. The area falls under humid sub tropical climate. The daily temperature during a year varies widely between minimum 4^{o} C and maximum 35^{o} C. The experimental site receives average annual rainfall of 2930 mm with high degree of temporal and spatial variations. The soil of experimental site was silty loam in texture, acidic in reaction (pH 5.3), and high in organic carbon (Walkaley and Black, 1.32 g kg^{-1}), available N (alkaline permanganate N, 193.8 kg ha^{-1}), available phosphorus (Olsen P, 10.4 kg ha^{-1}) and available K (ammonium acetate K, 210.5 kg ha^{-1}).

The experiment was laid out in randomized complete blocks design (RCBD) with 3 replications. Ten experimental treatments were applied for 2 successive years (2009 and 2010). The treatments included sole maize (cv. *Allrounder*) planted at the rate of 55,500 plants ha^{-1}, the three intercropping treatment mixtures of maize with cowpea, frenchbean and blackgram (cv. CP 04, *Anupama*, PU 31, respectively) were 1: 1, 1: 2 and 1: 5 maize+ cowpea, 1: 1, 1: 2 and 1: 5 maize+ frenchbean and 1: 1, 1: 2 and 1: 5 maize+ blackgram. The intercrops were planted at the rate of 3, 33,300 plant ha^{-1} each and as per the treatment different plant populations were assigned. As fixing the plant density of legumes, we modified the proportion of maize in the mixtures of each of three planting types in the proportions of 100:31, 100:62 (additive series) and 60:80 (replacement series) maize-legume, respectively, were grown for each intercropping treatment.

Three legumes *viz.*, cowpea, frenchbean vegetable and blackgram pulse were included each at 1:1, 1:2 and 1:5 row proportions with maize. Maize was planted at 90 cm in between two rows in 1: 1 and 1: 2 ratios but in case of 1: 5 row proportions, maize was planted 180 cm between two rows with an intra row spacing of 20 cm. The recommended basal dose of fertilizer for maize (40 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1}), cowpea (25 kg N, 75 kg P_2O_5 and 60 kg K_2O ha^{-1}), french bean (62.5 kg N, 100 kg P_2O_5 and 75 kg K_2O ha^{-1}) and blackgram (25 kg N, 60 kg P_2O_5 and 50 kg K_2O ha^{-1}) were applied at sowing and incase of maize, remaining nitrogen (40 kg N ha^{-1}) was applied 40 days after sowing (DAS). In case of intercropping treatments, fertilizers were applied proportionate to the sole optimum population for main and intercrop separately. Maize equivalent yields (MEY) in different treatments were worked out taking in to consideration the price of maize and the legumes component at the time of their harvest.

Plant height was measured from the surface of the soil to the tip of the topmost leaf at harvest. Leaf area (LA), leaf area index (LAI) and dry matter production (DMP) was estimated at 120 DAS. For DMP five plants were selected from each plot and separated by leaf, stem and cob and air dried for two days and kept in oven at 70°C for 48 hours. Finally sum of dry matter of plant parts are considered as DMP per plant. Solar radiation interception (SRI) was measured two times during the growing season (55 and 70 DAS) between 12-14 hours on occasions. Lux meter was used to measure SRI above the plant canopy and the soil surface at five randomly selected locations within each plot. Mean values for each plot were then used to calculate the percentage of SRI intercepted by plant canopy (Ghanbai-Bonjar, 2000). The soil water balance was expected to be influenced by different cropping systems. Soil water content at 0-0.25 m depth was determined on two occasions (55 and 70 DAS) during the growing season. Soil samples were taken from three locations within each plot and soil moisture content was determined separately by gravimetric measurement. Soil temperature was also recorded at a depth of 0-10 cm below the surface on two occasions (55 and 70 DAS) in all plots, using a soil thermometer. The different parameters were statistically analyzed by SAS 9.2 programme. The significance of treatment effects was determined by *F*-test. The significance of the difference between means of two treatments was tested using least significant difference (LSD) at 5% probability level.

RESULTS AND DISCUSSION

Effect on growth attributes

Data depicted in table 1 clearly indicated that mean from both the years, significantly taller plants, LA, LAI and DMP were observed with sole maize. The lowest plant height was recorded on 1: 5 maize+ blackgram intercropping followed by 1: 5 maize+ frenchbean intercropping. Increase in plant height under maize sole treatment was due to the fact that the wider space available in sole maize reduced the competition of light and nutrients, which probably provided favourable physical environment and helped the plant to grow taller. Increase in plant height under sole maize sowing was also observed by Hugar and Palled (2008).

TABLE 1. Growth attributes of maize as influenced by maize-legumes intercropping (2009 and 2010 and mean of both the years)

Treatment	Plant height (cm)			Leaf area (cm^2)			LAI			TDM (g plant^{-1})		
	2009	2010	Mean	2009	2010	Mean	2009	2010	Mean	2009	2010	Mean
Sole maize	206.2^{a}	175.1^{a}	190.7	3215.0^{a}	3150.0^{a}	3182.5	1.79^{a}	1.75^{a}	1.77	214.6^{a}	223.7^{a}	219.2
Maize: cowpea												
1:1	203.0^{ab}	162.5^{cd}	182.8	2940.7^{ab}	2960.0^{bcd}	2950.4	1.63a^{b}	1.64^{abc}	1.64	206.1^{ab}	208.3^{cde}	207.2
1:2	201.8^{ab}	165.5^{abc}	183.7	3082.0^{a}	3063.3^{ab}	3072.7	1.71^{a}	1.70^{ab}	1.71	203.2^{ab}	214.3^{bc}	208.8
1:5	198.0^{ab}	172.2^{ab}	185.1	3139.3^{a}	2766.7^{def}	2953.0	0.87^{e}	0.77^{e}	0.82	176.9^{b}	218.3^{ab}	197.6
Maize: french bean												
1:1	201.4^{ab}	160.7^{cd}	181.1	2520.0^{c}	2813.3^{def}	2666.7	1.40^{cd}	1.56^{cd}	1.48	202.6^{ab}	201.7^{e}	202.2
1:2	205.5^{a}	163.7^{bcd}	184.6	2737.7^{bc}	2636.7^{fg}	2687.2	1.52b^{cd}	1.46^{d}	1.49	201.6^{ab}	206.0^{de}	203.8
1:5	200.0^{ab}	157.8^{cd}	178.9	3026.7^{ab}	2546.7^{g}	2786.7	0.84^{e}	0.71^{e}	0.77	205.4^{ab}	212.0^{bcd}	208.7
Maize: blackgram												
1:1	205.3^{ab}	155.5^{d}	180.4	2456.0^{c}	2883.3^{def}	2669.7	1.36^{d}	1.60^{bc}	1.48	204.0^{ab}	205.3^{de}	204.7
1:2	199.9^{ab}	157.1^{cd}	178.5	2753.3^{bc}	3026.7^{abc}	2890.0	1.53^{bc}	1.68^{abc}	1.61	202.2^{ab}	211.0^{cd}	206.6
1:5	197.1^{b}	157.5^{cd}	177.3	2924.0^{ab}	2666.7^{efg}	2795.4	0.81^{e}	0.74^{e}	0.78	205.1^{ab}	215.0^{bc}	210.1
LSD at 0.05	8.15	9.56		313.77	240.97		0.16	0.12		34.7	7.31	
Pr>F	NS (0.2934)	*(0.0047)		* (0.0007)	*(0.0006)		**(0.001)	**(0.001)		NS (0.7186)	*(0.0002)	

LAI: leaf area index; TDM: total dry matter

LSD: least significant difference; NS: non significant; same letters in column are comparable to each other whereas different letters show statistically significant difference among the treatments; * significant at 5% and ** significant at 1%

LA was recorded higher on sole maize followed by 1: 2 maize+ cowpea intercropping and 1: 5 maize+ cowpea intercropping. But rest of intercrop did not show any trend. However, 1: 5 maize+ frenchbean intercropping and 1: 2 maize+ blackgram intercropping recorded higher LA on respective maize based intercropping combinations. Similarly, LAI was recorded significantly higher on sole maize followed by 1: 2 maize+ cowpea intercropping and 1: 1 maize+ cowpea intercropping all are statistically comparable. However, the lowest LAI was recorded on 1: 5 combination of maize with frenchbean, blackgram and cowpea respectively. DMP was statistically similar to each other during 2009 but it varied in 2010. The highest DMP was recorded on sole maize followed by 1: 5 maize+ blackgram intercropping, but 1: 5 maize+ cowpea intercropping was 10.9% lower in DMP followed by 1: 1 maize+ frenchbean intercropping and 1: 1 maize+ blackgram intercropping. Similar finding was also reported by Eskandari and Ghanbari (2010) in wheat-bean intercropping.

TABLE 2. Yield attributes and yield of maize and intercrop as influenced by maize-legumes intercropping (2009 and 2010 and mean of both the years)

Treatment	No. of seeds (cob^{-1})			Grain yield (kg ha^{-1})			Intercrop yield (kg ha^{-1})			Maize equivalent grain yield (kg ha^{-1})		
	2009	2010	Mean	2009	2010	Mean	2009	2010	Mean	2009	2010	Mean
Sole maize	442.3^{abc}	567.1^{ab}	504.7	4468.3^{a}	4800.0^{a}	4634.2	-	-	-	4468.3^{f}	4800.0^{f}	4634.2
Maize: cowpea												
1:1	411.0^{cd}	597.0^{a}	504.0	4285.0^{ab}	4675.0^{b}	4480.0	1356.0	2266.7	1811.4	5791.7^{c}	7168.5^{c}	6480.1
1:2	424.3^{abc}	525.0^{bcd}	474.7	4170.0^{b}	4600.0^{bc}	4385.0	2110.0	3700.0	2905.0	6514.4^{b}	8694.4^{a}	7604.4
1:5	464.0^{ab}	533.2^{bc}	498.6	2252.0^{d}	2800.0^{e}	2526.0	4358.0	4366.7	4362.4	7094.2^{a}	7651.9^{b}	7373.0
Maize: french bean												
1:1	366.3^{de}	495.5^{cde}	430.9	4115.0^{b}	4350.0^{d}	4232.5	1156.0	2313.3	1734.7	5142.6^{e}	6323.0^{d}	5732.8
1:2	421.3^{bc}	487.7^{cde}	454.5	3842.3^{c}	4600.0^{bc}	4221.2	1780.0	3233.3	2506.7	5424.6^{de}	7440.7^{b}	6432.7
1:5	475.0^{a}	460.6^{ef}	467.8	2267.3^{d}	2700.0^{e}	2483.7	3566.0	3516.7	3541.4	5437.1^{d}	5825.9^{e}	5631.5
Maize: blackgram												
1:1	330.7^{e}	476.2^{def}	403.5	4138.0^{b}	4500.0^{c}	4319.0	410.0	470.0	440.0	5231.3^{de}	5736.7^{e}	5484.0
1:2	417.0^{bcd}	431.4^{f}	424.2	3733.3^{c}	4650.0^{bc}	4191.7	620.0	916.7	768.4	5386.7^{de}	7044.4^{c}	6215.6
1:5	461.7^{abc}	428.4^{f}	445.1	2148.3^{d}	2800.0^{e}	2474.2	1152.0	1116.7	1134.4	5220.3^{de}	5677.8^{e}	5449.0
LSD at 0.05	51.26	50.65		194.83	137.14					288.95	222.65	
Pr>F	*(0.003)	**(<0.0001)		**(<0.0001)	**(<0.0001)					**(<0.0001)	**(<0.0001)	

LSD: least significant difference; NS: non significant; same letters in column are comparable to each other whereas different letters show statistically significant difference among the treatments; * significant at 5% and ** significant at 1%

Effect on yield attributes and yield

Number of grains cob^{-1} is an important yield attributes which directly relate to yield. Data presented in table 2 showed that the highest grain numbers mean of two years was recorded in sole maize followed by 1: 1 maize+ cowpea and 1: 5 maize+ cowpea. However, the lowest mean grain numbers was recorded in 1: 1 maize+ blackgram. The intercropping of blackgram with maize, all the combinations grain numbers were lower than the respective combinations of other intercrops. Santalla *et al.* (2001) have recorded in bush bean that, pulses leave 20-25 kg ha^{-1} of nitrogen in the soil at the time of harvest, which is utilized by the companion crop and tremendous leaf fall will form best source of organic matter, which leads to increase in yield attributing characters. The maize grain yield was recorded significantly higher in sole maize followed by 1: 1 maize+ cowpea. However, 1: 5 maize+ blackgram recorded with the tune of 87.3% lower grain yield followed by 1: 5 maize+ frenchbean and 1: 5 maize+ cowpea (86.6 and 83.5%, respectively). But, intercropping of crops with maize at 1: 2 proportion recorded 10.6, 9.8 and 5.7% for blackgram, frenchbean and cowpea, respectively. Similar findings were also reported by Ullah *et al.* (2007) in soybean and greengram intercrop with maize. The intercrop yield varies as per the space given to intercrop in between maize rows. In 1: 1 proportion the intercrop yield was recorded 157.8, 140.8 and 104.2% lower for blackgram, cowpea and frenchbean respectively over their respective 1: 5 proportions. However, 1: 2 proportion, 50.2, 47.6 and 41.3% lower than the 1: 5 proportions of cowpea, blackgram and frenchbean, respectively. Consequently, MEY was higher in all the combination of intercrop with different row proportions. The highest MEY was recorded 64.1% on 1: 2 maize+ cowpea followed by 1: 5 maize+ cowpea (59.1%). However, 1: 5 maize+ blackgram registered 17.6% higher than the sole maize followed by 1: 1 maize+ blackgram (18.3%). The yield increment in sole maize is only due to less competition for sunlight, space, water and nutrients as it was in intercrops having shading effect curtail efficient utilization of natural resources and restrict growth of maize from initial stages to harvest resulted in yield competition in intercrop (Yilmaz *et al.*, 2008). The MEY was recorded higher because of additional yield harvested in between the maize row. Similar findings were also obtained by Hussain *et al.* (2003) and Haque *et al.* (2008). Ghosh *et al.* (2004) also reported that maximum resource potential can be obtained through use of different legumes with maize. Intercropping has the high growth and yield potential, yield recovery and land utilization. Improper row space has very low resource use, because of inadequate use of inputs and lack of appropriate crop management technology.

Solar radiation interception (SRI)

Percentage of SRI interception was significantly ($P \leq 0.05$) affected by various intercropping with different row proportion (Table 3). The mean SRI interception averaged over years and dates was recorded higher on 1: 5 maize +

cowpea intercropping followed by 1: 5 maize + cowpea over sole maize. However, the interception was recorded higher on all 1: 5 crop combinations followed by 1: 2 and 1: 1. Among the years, 2010 recorded comparatively higher interception than 2009 might be due to better crop coverage and growth attributes (Table 1). Along with this, the SRI interception was noticed higher at 75 DAS over 50 DAS. The above findings might be due to different in vertical arrangement of foliage and canopy architecture of intercrop components, may lead to more SRI interception by intercropping compared with sole crops (Keating and Carberry, 1993). More SRI interception by different intercropping systems has been reported (Midmore *et al.*, 1988; Ghanbari-Bonjar, 2000).

TABLE 3. Solar radiation interception as influenced by maize-legumes intercropping (2009 and 2010 and mean of both the years)

Treatment	Solar radiation interception (%)					
	50 DAS			75 DAS		
	2009	2010	Mean	2009	2010	Mean
Sole maize	45.10^{g}	47.30^{d}	46.20	61.70^{h}	67.03^{f}	64.37
Maize: cowpea						
1:1	52.10^{e}	60.00^{abc}	56.05	76.00^{ef}	83.40^{cd}	79.70
1:2	56.00^{cd}	63.10^{ab}	59.55	81.80^{cd}	87.43^{bc}	84.62
1:5	62.33^{a}	67.83^{a}	65.08	91.50^{a}	92.97^{a}	92.24
Maize: french bean						
1:1	48.17^{fg}	53.27^{cd}	50.72	70.97^{g}	78.00^{e}	74.49
1:2	53.17^{de}	56.93^{bc}	55.05	77.30^{ef}	82.00^{de}	79.65
1:5	58.10^{bc}	60.20^{abc}	59.15	85.50^{bc}	84.00^{cd}	84.75
Maize: blackgram						
1:1	50.50^{ef}	58.20^{bc}	54.35	74.23^{fg}	82.10^{de}	78.17
1:2	55.23^{cd}	62.00^{ab}	58.62	79.17^{de}	85.60^{bcd}	82.39
1:5	59.33^{ab}	57.70^{bc}	58.52	89.03^{ab}	89.07^{ab}	89.05
LSD at 0.05	3.08	8.12		4.35	4.13	
Pr>F	**(<.0001)	*(0.0047)		**(<.001)	**(0.0001)	

LSD: least significant difference; NS: non significant; same letters in column are comparable to each other whereas different letters show statistically significant difference among the treatments; * significant at 5% and ** significant at 1%

TABLE 4. Soil temperature as influenced by maize-legumes intercropping (2009 and 2010 and mean of both the years)

Treatment	Soil temperature (°C)					
	50 DAS			75 DAS		
	2009	2010	Mean	2009	2010	Mean
Sole maize	29.70^{a}	30.60^{a}	30.15	28.50^{a}	28.77^{a}	28.64
Maize: cowpea						
1:1	28.20^{bc}	27.17^{cde}	27.69	26.10^{bc}	26.73^{bcd}	26.42
1:2	27.50^{bcd}	26.50^{ef}	27.00	25.47^{cd}	26.13^{cde}	25.80
1:5	26.80^{d}	25.67^{f}	26.24	24.53^{d}	25.33^{e}	24.93
Maize: french bean						
1:1	28.70^{ab}	28.30^{b}	28.50	26.90^{b}	27.63^{b}	27.27
1:2	28.40^{b}	27.60^{bcd}	28.00	26.20^{bc}	27.10^{bc}	26.65
1:5	27.67^{bcd}	26.77^{de}	27.22	25.53^{bcd}	26.23^{cde}	25.88
Maize: blackgram						
1:1	28.50^{ab}	27.90^{bc}	28.20	26.47^{bc}	27.03^{bc}	26.75
1:2	27.93^{bcd}	27.13^{cde}	27.53	25.70^{bcd}	26.40^{cde}	26.05
1:5	27.13^{cd}	26.33^{ef}	26.73	25.23^{cd}	25.90^{de}	25.57
LSD at 0.05	1.22	0.87		1.40	1.08	
Pr>F	*(0.0047)	**(0.0001)		**(<0.0012)	*(0.0002)	

LSD: least significant difference; NS: non significant; same letters in column are comparable to each other whereas different letters show statistically significant difference among the treatments; * significant at 5% and ** significant at 1%

Soil temperature and moisture

Soil temperature was significantly influenced by different intercrop and various row proportions, data depicted in table 4 clearly show that the soil temperature averaged over years and dates was recorded higher on sole maize followed by 1: 1 maize+ frenchbean intercrop. However the lower soil temperature was recorded on 1: 5 maize+ cowpea intercrop. In general, 1: 5 row proportion of intercrop recorded little lower soil temperature. Similarly, cowpea recorded lower soil temperature followed by blackgram and frenchbean in particular. Over the year did not show any trend, but among the observation dates soil temperature was recorded lower on 75 DAS then the 55 DAS. The moisture content of soil, determined by gravimetric method, was significantly influenced by different intercrop and various row proportion (Table 5). Soil moisture content was recorded higher in 1: 5 maize + cowpea intercrop followed by 1: 5 maize + blackgram intercrop. However, the lowest soil moisture was measured on sole maize. Over the years, during 2010 comparatively higher soil moisture was registered for both the sampling dates. The 1: 5 ratio recorded comparatively higher soil moisture followed by 1: 2 and 1: 1, but cowpea conserve more soil moisture followed by blackgram and least by frenchbean. High light interception by intercrops caused higher shading and, therefore, lowers soil temperature, which agrees with the finding of Harris and Natarajan (1987) who suggested that the micro-climate within the canopy of cropping systems were altered, so that shading reduced canopy temperature. Thus, it seems that percent of light interception by canopies would be a major factor affecting soil temperature. Intercropping may be more efficient at exploiting a larger total soil volume if component crops have different rooting habits, especially depth of rooting (Ahlawat *et al*., 1985). Lower soil moisture content in intercrops treatments compared to sole crop could not be due to higher evaporation from the soil surface, because soil temperatures under intercrops were lower than sole crops (Table 5).

TABLE 5. Soil moisture as influenced by maize-legumes intercropping (2009 and 2010 and mean of both the years)

Treatment	Soil moisture content (%)					
	50 DAS			75 DAS		
	2009	2010	Mean	2009	2010	Mean
Sole maize	22.67^{f}	24.93^{f}	23.80	25.20^{f}	26.50^{f}	25.85
Maize: cowpea						
1:1	25.20^{cd}	28.43^{cd}	26.82	30.77^{bcd}	30.13^{cde}	30.45
1:2	26.13^{bc}	29.17^{abc}	27.65	31.20^{bc}	31.03^{bc}	31.12
1:5	27.20^{a}	30.30^{a}	28.75	32.70^{a}	32.53^{a}	32.62
Maize: french bean						
1:1	24.10^{e}	26.83^{e}	25.47	28.80^{e}	28.97^{e}	28.89
1:2	24.87^{de}	27.50^{de}	26.19	29.60^{de}	29.37^{de}	29.49
1:5	25.70^{cd}	29.07^{abc}	27.39	30.23^{cd}	30.03^{cde}	30.13
Maize: blackgram						
1:1	24.73^{de}	27.93^{cde}	26.33	29.67^{de}	29.57^{de}	29.62
1:2	25.50^{dc}	28.73^{bcd}	27.12	30.50^{bcd}	30.57^{bcd}	30.54
1:5	26.80^{ab}	29.97^{ab}	28.39	31.63^{ab}	31.53^{ab}	31.58
LSD at 0.05	1.01	1.30		1.20	1.23	
Pr>F	**(<0.0001)	**(<0.0001)		**(<0.0001)	**(<0.0001)	

LSD: least significant difference; NS: non significant; same letters in column are comparable to each other whereas different letters show statistically significant difference among the treatments; * significant at 5% and ** significant at 1%

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