

Effect of intercropped fodder cowpea on maize and system productivity in maize + fodder cowpea intercropping systems

There has been substantial gain in food production over the past few decades, still the task of meeting the food, feed, fodder and fuel needs of increasing human and livestock population remain a formidable challenge to scientific community. India is the largest country which is having 529.7 millions of livestock population (Anon., 2010). The total area under fodder crops is 6.6 m ha which constitutes about 4% of cultivated area and is insufficient to meet the fodder requirement of existing livestock. It is often not possible to set aside arable land for fodder production alone, as cultivable land is not enough for food grain production. Agriculture land is shrinking day by day as it is used for non - agricultural purposes. It is rather inevitable to accommodate fodder production in existing crops /cropping systems. There is ample inter – space in widely spaced crops like grain maize, sorghum, bajra, hybrid cotton, red gram *etc.*, which can be advantageously used to raise short duration pulse crops such as fodder cowpea or multi – cut fodder crops without much reduction in the main crop yields. Maize is being widely spaced crop, cowpea can be introduced as fodder crop by altering the plant geometry of hybrid grain maize.

A field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *kharif* 2013 on *Alfisols*. The experimental soil comprised of red sandy loam soil, neutral in reaction, low in available N, medium in organic carbon and phosphorus and high in available potassium. Four dates of sowing of maize (Simultaneous, 1st, 2nd and 3rd week) intercropped with fodder cowpea at 1:1 and 1:2 row proportions in maize and fodder cowpea was harvested at 60 days after sowing. The experiment was laidout in Randomized Complete Block Design with 11 treatments replicated thrice. Fodder cowpea was harvested at 60 DAS and maize was harvested at physiological maturity. A rainfall of 711.1 mm was received during the growing season. Maize was planted at 60 x 20 cm and 90 x 20 cm with one and two rows of fodder cowpea, in 1:1 and 1:2 row proportions. The recommended basal dose of fertilizer for maize (50 kg N, 50 kg P₂O₅ and 25 kg K₂O ha⁻¹) and fodder cowpea (15 kg N and 30 kg P₂O₅ ha⁻¹) were applied at sowing. In case of maize, remaining nitrogen (50 kg ha⁻¹) was

applied at 40 DAS. Intercropping treatments received fertilizers in proportion to the sole optimum population for main and intercrop separately. Observations on grain and stover yield of maize and green fodder yield of fodder cowpea were recorded at harvest. Maize equivalent yield (MEY) was calculated by considering the prices of both the crops using following formulae and gross return calculated as per standard procedure. The data was analyzed and interpreted.

$$\text{MEY (kg ha}^{-1}\text{)} = \frac{\text{Maize yield (kg ha}^{-1}\text{)} \times \text{Price (₹ kg}^{-1}\text{)} + \text{Pigeonpea yield (kg ha}^{-1}\text{)} \times \text{Price (₹ kg}^{-1}\text{)}}{\text{Maize Price (₹ kg}^{-1}\text{)}} \times 100$$

$$\text{Per cent light transmission} = \frac{\text{Light intensity at ground level} - \text{Light intensity above crop canopy}}{\text{Light intensity at ground level}} \times 100$$

The perusal of data (Table 1) indicate that maize sown at normal planting (60 x 20 cm) recorded significantly higher grain yield (5519 kg ha⁻¹) and stover yield (7658 kg ha⁻¹) over sole maize at 90 x 20 cm and all intercropping treatments except simultaneous sowing of maize + fodder cowpea and maize sown after 1 week at 1:1 row proportion. In normal planting of sole maize better space and light availability, resulted in significantly higher maize yield. Results agree with the findings of Kumar (2008) and Hirpa (2013).

Among the intercropping treatments simultaneous sowing of maize + fodder cowpea at 1:1 row proportion recorded significantly higher grain yield (5349 kg ha⁻¹) and stover yield (7581 kg ha⁻¹) over all other intercropping treatments except, maize sown after 1 week at 1:1 row proportion. This might be attributed to the higher values of growth and yield components and reduced intercrop competition from fodder cowpea for growth resources (light, nutrients and space) compared to delayed sowing of maize after 1st, 2nd and 3rd weeks both at 1:1 and 1:2 row proportions. The results are confirmed with the findings of Aravinda *et al.* (2004), Ashoka *et al.* (2013) and Ahmed *et al.* (2013).

Table 1. Yield of maize, green fodder yield (GFY) of cowpea and maize equivalent yield as influenced by different treatments

Treatment	Grain yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)	GFY of (t ha ⁻¹)	Cowpea MEY (kg ha ⁻¹)
T ₁ – Maize (60 cm x 20 cm) + 1 row cowpea, simultaneous sowing	5349	7581	16.47	6742
T ₂ – Maize (60 cm x 20 cm) + 1 row cowpea, maize sowing after 1 week	5120	6713	17.42	6593
T ₃ – Maize (60 cm x 20 cm) + 1 row cowpea, maize sowing after 2 weeks	3277	5941	24.69	5366
T ₄ – Maize (60 cm x 20 cm) + 1 row cowpea, maize sowing after 2 weeks	2012	4861	28.40	4415
T ₅ – Maize (90 cm x 20 cm) + 2 rows cowpea, simultaneous sowing	4153	6519	20.29	5870
T ₆ – Maize (90 cm x 20 cm) + 2 rows cowpea, maize sowing after 1 week	3584	6183	22.72	5506
T ₇ – Maize (90 cm x 20 cm) + 2 rows cowpea, maize sowing after 2 weeks	2421	5131	29.84	4945
T ₈ – Maize (90 cm x 20 cm) + 2 rows cowpea, maize sowing after 3 weeks	1464	4175	30.96	4083
T ₉ – Sole maize (60 cm x 20 cm)	5519	7658	-	5518
T ₁₀ – Sole maize (90 cm x 20 cm)	4331	7041	-	4330
T ₁₁ – Sole fodder cowpea (30 cm x 10 cm)	-	-	35.36	35360
S.E.m ±	257	151	2.13	186
C.D. (0.05)	765	447	6.39	549

Sole fodder cowpea recorded significantly higher green fodder yield (35.36 t ha^{-1}) as compared to all other intercropping treatments except maize sown after 2 and 3 weeks at 1:2 row proportion. Among intercropping treatments, maize sown 3 weeks after with fodder cowpea at 1:2 row proportion recorded significantly higher total green forage yield (30.96 t ha^{-1}) compared to all other intercropping treatments. The extent of increase in yield of fodder cowpea, where maize was sown 3 weeks after with cowpea at 1:2 row proportion over maize sown simultaneously and after 1st and 2nd week at 1:2 row proportion was to the tune of 34.46, 26.61 and 3.61 per cent, respectively. The extent of yield increase in yield of fodder cowpea, where maize was sown 3 weeks after with cowpea at 1:2 row proportion over maize sown simultaneously and 1st, 2nd and 3rd weeks at 1:1 row proportion was to the tune of 46.80, 43.73, 20.25 and 8.26 per cent, respectively.

Simultaneous sowing of maize with fodder cowpea at 1:1 row proportion recorded significantly higher MEY ($6742. \text{kg ha}^{-1}$) over all other intercropping treatments except maize sown after 1 week at 1:1 row proportion. This might be attributed due to relatively higher yield of maize in normal planting at 1:1 row proportion sown simultaneously with cowpea and additional yield of green fodder of cowpea. Jamaluddin *et al.*, (2009) revealed that maize + spinach intercropping system produced significantly higher maize equivalent yield compared to sole crop of maize. Similar findings were also reported by Parvender *et al.* (2010).

Intercropping treatments recorded significantly higher land equivalent ratio (LER) and area time equivalent ratio (ATER)

values over sole maize (Table 2). Among intercropping treatments, the higher LER and ATER (1.53 and 1.25, respectively) was noticed in simultaneous sowing of maize + fodder cowpea (1:2) over all other intercropping treatments except maize sown simultaneously and after 1st week at 1:1 and maize sown after 1st week at 1:2 row proportion, with which it was on par.

Sole fodder cowpea (T_{11}) at 55 DAS recorded significantly lower LTR (4.59%) and higher light absorption (95.41%) over sole maize at both planting geometries (60 x 20 and 90 x 20 cm) and other intercropping treatments.

Among intercropping treatments, maize sown after 3 weeks at 1:2 row proportion (T_8) recorded significantly lower (Light Transmission Ratio (LTR) (9.15 %) and higher light absorption (90.8%) compared to all other intercropping treatments. This is because of fodder cowpea produces profuse branching and faster growth rate, which covers the soil surface and increase the light absorption. The results agree with the findings of Sinha *et al.* (2005).

The net return were significantly higher in maize + fodder cowpea simultaneous sowing at 1:1 row proportion ($\text{₹ } 66088 \text{ ha}^{-1}$) than all other treatments except maize sown after 1 week at 1:1 row proportion with which it was on par. Whereas, significantly higher B:C (2.98) was recorded in maize sown simultaneously with cowpea at 1:1 row proportion over all other treatments except maize sown after 1 week at 1:1 row proportion. This is mainly attributed to significantly higher gross returns as a result of higher maize equivalent yield. Similar results were also reported by Parvender *et al.* (2010) and Sylvester *et al.* (2014).

Table 2. LER, ATER, LTR (%) and economics as influenced by different treatments.

Treatment	LER	ATER	Per cent light transmission at 55 DAS	Net returns (₹ ha^{-1})	B:C
T_1 – Maize (60 cm x 20 cm) + 1 row cowpea, simultaneous planting	1.43	1.20	11.71	66088	2.98
T_2 – Maize (60 cm x 20 cm) + 1 row cowpea, maize sowing after 1 week	1.42	1.17	11.61	64296	2.93
T_3 – Maize (60 cm x 20 cm) + 1 row cowpea, maize sowing after 2 weeks	1.29	0.94	11.12	51919	2.56
T_4 – Maize (60 cm x 20 cm) + 1 row cowpea, maize sowing after 3 weeks	1.12	0.79	11.00	38556	2.16
T_5 – Maize (90 cm x 20 cm) + 2 rows cowpea, simultaneous planting	1.53	1.25	9.60	57451	2.78
T_6 – Maize (90 cm x 20 cm) + 2 rows cowpea, maize sowing after 1 week	1.47	1.15	9.45	53879	2.67
T_7 – Maize (90 cm x 20 cm) + 2 rows cowpea, maize sowing after 2 weeks	1.40	0.99	9.37	47797	2.48
T_8 – Maize (90 cm x 20 cm) + 2 rows cowpea, maize sowing after 3 weeks	1.21	0.78	9.15	37836	2.17
T_9 – Sole maize (60 cm x 20 cm)	1.00	1.00	45.05	47477	2.74
T_{10} – Sole maize (90 cm x 20 cm)	1.00	1.00	58.97	34923	2.44
T_{11} – Sole fodder cowpea (30 cm x 10 cm)	1.00	1.00	4.59	42968	4.14
S.E.m ±	0.03	0.05	0.80	1740	0.17
C.D. (0.05)	0.10	0.14	2.37	5135	0.51

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(Received: August, 2014 ; Accepted: March, 2016)

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