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Rajni Sinha
Research Scholar, Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

JP Singh
Professor, Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Rajesh Kumar Singh
Associate Professor, Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Ram Kumar Singh
Professor, Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Corresponding Author:
Rajni Sinha
Research Scholar, Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Effect of legume intercropping and foliar spray of zinc and iron on maize

Rajni Sinha, JP Singh, Rajesh Kumar Singh and Ram Kumar Singh

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Abstract
Intercropping is growing two or more crops simultaneously on a piece of land to harness the efficient use of resources to increase per unit land productivity. Maize being a wide row crop provides ample scope to accommodate short duration crops as intercrop. Legume crops are good option to be grown as intercrops in the rows of maize. A two-year experiment was conducted at Agriculture Research farm, Banaras Hindu University, Varanasi in *Kharif* season to study the effect of foliar spray of zinc and iron on maize + legume intercropping. The experiment was laid out in split plot design in three replications. Legume intercrops were assigned in main plots whereas foliar treatments in subplot. Three legume intercrops and four foliar treatments were taken. A total of 12 combinations were allocated randomly in the plots. To evaluate growth of maize data for plant height, dry matter accumulation and Leaf Area Index was calculated at regular time intervals. Experimental findings proved that maize intercropped with cowpea along with foliar spray of 2% $ZnSO_4$ and 2% $FeSO_4$ at 30 DAS and 60 DAS results into highest growth of maize in Varanasi.

Keywords: Intercropping, foliar spray and days after sowing

Introduction
Maize (*Zea mays* L.) is one of the most versatile emerging crops having wider adaptability and is grown in diverse seasons and ecologies for various purposes (Dass *et al.*, 2012) [1]. It is cultivated in more than 165 countries on an area of 177 million hectare with a production of 875 million tonnes and productivity of 5 tonnes per ha $^{-1}$ (Yadav *et al*., 2014) [2]. Maize holds an important place in Indian economy and contributes significantly in the Gross Domestic Product (IIMR, 2015). The population is increasing exponentially and it has to fulfil its food requirements. An attractive strategy for increasing productivity and labour utilization per unit area of available land use is to intensify land use (Seren and Brintha, 2010) [3]. Maize is a potential crop for crop diversification due to its many types and intensification because of its wider row spacing and erect plant type having non-tillering growth habit, which can accommodate short duration pulses, flowers, vegetables, etc. as intercrops (Yadav *et al.*, 2014) [2]. Intercropping, the practice of growing two or more crops together in the same row or in adjacent rows close enough for biological interaction, is followed by many farmers around the world to increase overall crop productivity and profitability, improve pest and disease management, and gain better use efficiency of nutrient, water, and light resources (Francis *et al.*, 1986; Khan *et al*., 2014) [4, 5].

Materials and Methods
A two-year field experiment was conducted at the Agriculture Research Farm, Banaras Hindu University in *kharif* 2016-17 to study the effect of legume intercropping and foliar spray of zinc and iron on maize crop. the present study was conducted in Gangetic Alluvial soil (entisols) *i.e.* sandy clay loam in texture, having slightly alkaline in reaction, low in organic carbon and low available nitrogen, medium in available phosphorus and potassium, low in zinc and medium in iron. The experiment was laid out in split plot design with three replications assigning three intercropping systems in main plots. These were designated as I_1- Maize + mung bean (1:1), I_2 -Maize + urdbean (1:1) and Maize + cowpea (1:1). Each main plot was further divided into three sub plots to accommodate sub plot treatments *i.e.* foliar application of nitrogen. These comprised RDF (F_1) regarded as control, RDF + 2% spray of $ZnSO_4$ at 30 and 60 DAS (F_2), RDF + 2% spray of $FeSO_4$ at 30 and 60 DAS (F_3) and RDF + 2% spray of $ZnSO_4$ + 2% spray of F_4 $FeSO_4$ at 30 and 60 DAS regarded as F_4. Thus, a total of 12 treatment combinations were tested in the study and were replicated thrice.

Varieties taken in the experiment were BIO 9544, PDM-13, T9 and CP-6 for maize, mungbean, urdbean and cowpea respectively. Foliar spray of micronutrients was done as per treatment. Other crop management practices were followed as per the recommendation of the area. Treatment details have been presented in Table 1.

Table 1: Treatment details

Treatment name	Treatment Details
T_1 (I_1F_1)	Maize + mungbean (1:1) with recommended dose of fertlizer
T_2 (I_1F_2)	Maize + mungbean (1:1) with recommended dose of fertilizer + foliar spray of 2% $ZnSO_4$ at 30 DAS
T_3 (I_1F_3)	Maize + mungbean (1:1) with recommended dose of fertilizer + foliar spray of 2% $ZnSO_4$ and 2% $FeSO_4$ at 30 DAS
T_4 (I_1F_4)	Maize + mungbean (1:1) with recommended dose of fertilizer + foliar spray of 2% $ZnSO_4$ and 2% $FeSO_4$ at 30 and 60 DAS
T_5 (I_2F_1)	Maize + urdbean (1:1) with recommended dose of fertlizer
T_6 (I_2F_2)	Maize + urdbean (1:1) with recommended dose of fertilizer + foliar spray of 2% $ZnSO_4$ at 30 DAS
T_7 (I_2F_3)	Maize + urdbean (1:1) with recommended dose of fertilizer + foliar spray of 2% $ZnSO_4$ and 2% $FeSO_4$ at 30 DAS
T_8 (I_2F_4)	Maize + urdbean (1:1) with recommended dose of fertilizer + foliar spray of 2% $ZnSO_4$ and 2% $FeSO_4$ at 30 and 60 DAS
T_9 (I_3F_1)	Maize + cowpea (1:1) with recommended dose of fertlizer
T_{10} (I_3F_2)	Maize + cowpea (1:1) with recommended dose of fertilizer + foliar spray of 2% $ZnSO_4$ at 30 DAS
T_{11} (I_3F_3)	Maize + cowpea (1:1) with recommended dose of fertilizer + foliar spray of 2% $ZnSO_4$ and 2% $FeSO_4$ at 30 DAS
T_{12} (I_3F_4)	Maize + cowpea (1:1) with recommended dose of fertilizer + foliar spray of 2% $ZnSO_4$ and 2% $FeSO_4$ at 30 and 60 DAS

In the present study 120:60:40 was taken as N:P:K ratio for recommended dose of fertilizer in maize whereas it was 25:40:20 for mungbean, urdbean and cowpea. To evaluate effect on growth of maize data of plant height and biomass accumulation were recorded at 30, 55, 85 DAS and at harvest. Leaf area index of maize were calculated at the mentioned stages of data recording.

Results and Discussions

Plant height: legume intercropping and foliar spray of zinc and iron has significant effect on plant height recorded at various stages. Maize intercropped with maize attained the most plant height at all the stages of data recording compared to maize + mungbean and maize + urdbean intercropping. This in in agreement with finding of Geren *et al.* (2008) [7] where they reported highest value with cowpea (227.3 cm). Among various foliar spray treatments F_4 recorded the highest value for plant height in maize which was significantly higher than rest of the foliar treatments. Similar observation was found by Hossain *et al.* (2011) [8] who recorded the highest value for plant height with application of zinc in form of zinc sulphate.

Table 2: Height of maize at different stages as influenced by legume intercropping and foliar spray of zinc and iron

Treatments	30 DAS		55 DAS		80 DAS		Harvesting	
	2016	2017	2016	2017	2016	2017	2016	2017
Legume intercropping								
Maize + mungbean	88.95	96.25	105.24	110.65	137.23	142.40	141.65	221.02
Maize + urdbean	94.33	99.71	119.55	124.95	153.06	158.62	157.78	165.43
Maize + cowpea	105.35	110.48	162.46	168.98	203.37	211.09	210.69	148.55
S.Em±	1.90	2.32	2.92	5.30	5.99	6.59	6.07	6.51
CD (P=0.05)	7.47	9.11	11.47	20.80	23.53	25.88	23.82	25.56
Foliar spray								
F_1	95.50	100.80	112.85	117.97	145.94	151.13	150.34	157.57
F_2	94.45	102.07	124.93	130.55	159.80	165.84	165.99	174.10
F_3	99.11	104.57	130.84	137.62	167.01	173.29	172.37	180.75
F_4	95.68	101.14	147.72	153.30	185.46	192.55	191.47	200.90
S.Em±	2.69	2.93	3.19	3.39	3.91	4.76	3.90	4.15
CD (P=0.05)	NS	NS	9.47	10.07	11.62	14.14	11.58	12.32

Table 3: Dry matter accumulation of maize at different stages as influenced by legume intercropping and foliar spray of zinc and iron

Treatments	30 DAS		55 DAS		80 DAS		Harvesting	
	2016	2017	2016	2017	2016	2017	2016	2017
Legume intercropping								
Maize + mungbean	7.51	8.96	76.8	85.78	157.92	167.56	215.76	282.50
Maize + urdbean	8.26	9.20	83.74	90.05	166.47	177.27	235.11	248.78
Maize + cowpea	8.85	9.31	93.75	101.99	184.54	199.58	266.96	228.33
S.Em±	0.32	0.41	2.40	2.75	4.42	5.37	8.05	8.47
CD (P=0.05)	NS	NS	9.41	10.78	17.36	21.09	31.62	33.25
Foliar spray								
F_1	8.28	9.28	76.46	82.07	155.62	164.43	216.54	229.15
F_2	8.14	9.44	83.55	92.21	169.21	179.80	236.31	250.06
F_3	8.25	8.56	85.69	93.23	170.82	182.71	242.50	257.75
F_4	8.16	9.34	93.35	102.92	182.93	198.93	261.77	278.64
S.Em±	0.45	0.57	2.47	2.70	3.99	4.73	6.28	6.83
CD (P=0.05)	NS	NS	7.35	8.02	11.84	14.05	18.67	20.30

Dry matter accumulation: Intercropping with legume crops had significant positive impact on dry matter accumulation at 55 DAS and onwards advanced stages of data recording. Maize crop intercropped with cowpea recorded highest value of dry matter accumulation followed by maize + urdbean intercropping. This finding is in tune with that of Sahu and Ambawatia (2013). They reported significantly higher values of dry matter accumulation per plant when it was grown in system of intercropping with soybean or blackgram in row ratio of 1:1 at all the stages of plant growth as compared to the system of maize + pigeonpea grown in the row ratio of 1:1 and 2:2. Further, foliar treatment F4 resulted into highest value for dry matter accumulation at 55 DAS and next stages of data recording. This finding is in agreement with finding of Subramanian *et al*. (2008) [9]. They observed proportionate increase in the biomass of root and shoot in maize crop with increase in the level of zinc application as compared to those of control treatment.

Table 4: Leaf Area Index of maize at different stages as influenced by legume intercropping and foliar spray of zinc and iron

Treatments	25 DAS		55 DAS		85 DAS	
	2016	2017	2016	2017	2016	2017
Legume intercropping						
Maize + mungbean	1.84	1.92	2.97	3.20	3.82	4.05
Maize + urdbean	1.95	2.05	3.68	4.00	4.52	4.85
Maize + cowpea	2.09	2.18	4.29	4.62	5.14	5.47
S.Em±	0.05	0.03	0.14	0.15	0.13	0.15
CD (P=0.05)	NS	NS	0.56	0.60	0.52	0.60
Foliar spray						
F_1	1.96	1.95	2.93	3.22	3.78	4.07
F_2	1.94	2.01	3.60	3.80	4.43	4.65
F_3	2.02	2.13	3.75	4.07	4.60	4.92
F_4	1.92	2.11	4.31	4.67	5.16	5.52
S.Em±	0.04	0.04	0.14	0.16	0.14	0.16
CD (P=0.05)	NS	NS	0.42	0.47	0.41	0.47

Leaf Area Index: maize intercropped with maize obtained significantly higher leaf area index as compared to maize intercropped with urdbean and mungbean at 55 and 85 DAS. This finding is in tune of Saxena *et al*. (2004) [10] who reported significantly higher Leaf Area Index of maize in intercropping with soybean. Foliar treatment F_4 resulted into significantly higher value of Leaf Area Index at 55 and 85 DAS.

Summary and Conclusion

Legume intercropping and foliar nutrition of zinc and iron results into positive impact on growth on maize in Varanasi.

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