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Supplemental Irrigation, Green Manuring and Nitrogen Levels on Growth, Yield and Economics of Dry Land Maize

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A field experiment was conducted during North East Monsoon season of 2002 and 2003 at Tamil Nadu Agricultural University, Coimbatore to study the productive and economically viable integrated rainwater and nitrogen management practice for dryland maize under different rainfall situations. It is concluded that for early withdrawl of rainfall around 45 DAS, two supplemental irrigations given at tasseling and silking stages through run off recycling from farm pond increased growth, yield parameters, grain yield by 134 percent and net returns by Rs.3389 ha^{-1} over rainfed maize in 2002. For moisture stress at tasseling and soft dough stages, two supplemental irrigation increased growth, yield attributes, grain yield by 88 percent and net return by Rs. 3305 ha^{-1} over rainfed maize in 2003. Application of 40 kg N ha^{-1} with intercropping and incorporation of either sunnhemp or cowpea at 45 DAS increased yield and net returns of maize over sole maize with out inorganic nitrogen.

Keywords: Dryland maize, farmpond, runoff, supplemental irrigation, green manures, nitrogen

Area and demand of maize is gaining momentum due to its diversified use. Even though maize has got potential, the productivity is often limited due to moisture stress at critical stages and poor soil fertility in dry lands, especially low in organic matter as well as nitrogen content in soil. Therefore, use of chemical fertilizer alone may not keep pace with time in maintenance of soil health for sustaining the productivity. Present study was carried out to know the effect of integrated use of supplemental irrigation, green manuring and nitrogen application on productivity and profitability of maize.

Materials and Methods

The experiment was conducted at Tamil Nadu Agricultural University, Coimbatore during North East Monsoon seasons of 2002 and 2003. The soil was clay loam with pH 8.4, low in available N (140 kg ha^{-1}) and organic carbon (0.18%), medium in available P (19.36 kg ha^{-1}) and high in available K (365.2 kg ha^{-1}). The total rainfall received during the cropping period was 331mm, in 2002-03 and 315.8mm in 2003-04. The pond size was designed to hold the maximum runoff i.e 258m^3. The total run off water collected in the farm pond was 341 and 329m^3 during NEM season of 2002 and 2003 respectively. CO l maize was sown in first fortnight of October in 2002 and second fortnight of September in 2003. Seed rate of 20 kg ha^{-1} with a spacing of 45 x 20cm for maize cowpea var CO5 and sun hemp var CO l were sown as a green manure crops simultaneously as per the treatment in between maize rows. Recommended dose of 40 kg N ha^{-1} was applied in 2 splits as per the treatment. The treatment comprised 3 levels of supplemental irrigation (trained crop with out supplemental irrigation, one and two supplemental irrigation) through run off recycling at moisture stress period during critical stage of the crop were assigned to main-plots. In sub plot intercropping systems viz, sole crop maize + sunnhemp and maize +cowpea were allotted and in sub-sub plot 3 levels of N (0,20 and 0 kg ha^{-1}) were assigned. The experiment was laid out in split-split plot design and replicated thrice. The supplemental irrigation was given to the crop at the time of moisture stress period based on visual symptom. One irrigation was given at tasseling during both the years. Two supplemental irrigations were given at tasseling during both the

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years. Two supplemental irrigations were given at tasseling and silking stages during 2002 and tasseling and soft dough stages during 2002 and tasseling and soft dough stages during 2003. The irrigation was given to a depth of 1cm.

Results and Discussion

Supplemental irrigation at moisture stress period had a significant influence on growth and yield attributes of maize. Two supplemental irrigation given at tasseling and silking stages in 2002 and tasseling and soft dough stages in 2003 recorded higher growth parameters (Table 1) and yield attributes (Table 2) during both the years. This was due to improved plant water status which intern influenced the growth of the plant (Singh et al., 1997 and Dilipkumar, 2000). Thereby

Table 1. Growth parameters and yield attributes of dry land maize as influenced by supplemental irrigation, green manure intercropping and nitrogen levels.

Treatments	Plant height (cm) 90 DAS		Leaf area index – 90 DAS		DMP(kg/ha)- 90 DAS	
Supplemental irrigation	2002	2003	2002	2003	2002	2003
Without supplemental irrigation	167.3	170.1	5.10	5.14	5714	6210
One supplemental irrigation	169.1	172.2	5.35	5.45	6278	6772
Two supplemental irrigation	171.5	174.7	5.61	5.74	6921	7462
CD(P=0.05)	1.6	1.2	0.04	0.04	193	186
Green manures Sole crop	168.4	171.3	5.31	5.40	5996	6501
Maize+sunnhemp	169.9	172.9	5.38	5.47	6547	7054
Maize+cowpea	169.6	172.8	5.37	5.47	6368	6891
CD(P=0.05)	0.7	1.3	0.05	0.06	183	171
Nitrogen levels						
0	168.6	171.3	5.33	5.42	6006	6532
20	169.3	172.5	5.37	5.46	6291	6828
40	169.9	173.2	5.41	5.49	6616	7085
CD(P=0.05)	**0.9**	**0.8**	**0.03**	**0.04**	**110**	**119**

translocation of photosynthates from source to sink was higher which lead to increase in yield components under two supplemental irrigation. Dilipkumar and Ajiaykumar 2001 also reported similar type of observation.

The intercropping and incorporation of sunnhemp at 45 DAS recorded highest growth components (Table1) and yield attributes (Table2), which was comparable with cowpea intercropping in both the years. Increase in availability of nutrient and improved soil condition are the reason for better growth and yield components under these treatments stated by Dasareddy et al., 2001.

Application of 40 kg Nha^{-1} was superior in increasing the growth (Table1) and yield components (Table2) over lower levels. Higher availability of N in soil resulted in higher uptake by plants resulting in higher growth which ultimately increased the yield components as reported by vadivel et al., 2001.

Two supplemental irrigation significantly increased the maize grain yield by 134 percent and 88 percent over rainfed maize during 2002 and 2003 respectively which may be due to increased soil moisture at critical stage, helped to increase photosynthetic area as a result of

Table 2. Effect of supplemental irrigation, green manuring and nitrogen levels on yield attributes and yield of maize.

Treatments	Cob length (cm)		No.of grain row per cob		Test weight (g)		Grain yield (kg/ha)	
Supplemental irrigation	2002	2003	2002	2003	2002	2003	2002	2003
Withoutsupplemental irrigation	10.1	10.5	12.7	13.2	16.20	16.23	594	949
One supplemental irrigation	11.4	11.8	13.9	14.4	17.22	17.34	1023	1452
Two supplemental irrigation	12.4	13.1	15.0	15.7	18.08	18.20	1389	1784
CD(P=0.05)Green manures	0.6	1.0	0.8	1.1	0.83	0.83	94	90
Sole crop	11.0	11.4	13.5	14.0	16.61	16.66	840	1229
Maize+sunnhemp	11.5	12.0	14.0	14.7	17.21	17.28	1103	1506
Maize+cowpea	11.5	12.0	14.0	14.5	17.11	17.16	1062	1450
CD (P=0.05)								
Nitrogen levels	0.4	0.3	0.4	0.4	0.42	0.43	70	80
0	11.0	11.4	13.5	14.0	16.55	16.66	832	1183
20	11.3	11.8	13.9	14.4	17.01	17.06	1005	1413
40	11.6	12.2	14.2	14.8	17.37	17.38	1169	1588
CD (P=0.05)	**NS**	**NS**	**0.3**	**0.2**	**0.25**	**0.25**	**63**	**85**

which higher amount of photosynthates accumulated and it is translocated from source to sink, This cumulative effect resulted in higher grain (Table 2) and Stover yields (Table 3) under supplemental irrigation. Latatulu et al., 1982 observed increase in grain yield due to increase in soil moisture supply.

In both the years, higher grain (Table2) and stover yields (Table3) were recorded under incorporation of sunnhemp, which was comparable with cowpea. The percentage of increase in grain yield was 31 and 23 by incorporation of sunnhemp and 26 and 18 by cowpea over control in 2002 and 2003 respectively.

This may be due to improved physico chemical properties of soil which, in turns conserved more amount of moisture and ultimately yield.

Significant increase in grain and stover yield (Table2 and 3)was observed with the application of 40 kg N ha^{-1}. The increase of grain yield over control was 41 and 34 per cent during 2002 and 2003 respectively. As a result of higher availability and uptake of N, the growth and yield components of maize was increased which inturn enhanced the grain yield of maize. Vadivel et al.,2001 reported higher grain yield of maize with increasing N levels.

Interaction effects

Intraction effects between IXC,CXN and IXN were significant on grain yield of maize during both the years.In IXC interaction,at all irrigation regimes,intercropping of sunnhemp and incorporation recorded higher grain yield and it was comparable with intercropping of cowpea,but it was superior to sole crop of maize.Among the

Table 3. Effect of supplemental irrigation, green manuring and nitrogen levels on stover yield and economics of maize.

Treatments	Stover yield (kg/ha)		Net return (Rs.)		B:C ratio	
Supplemental irrigation	2002	2003	2002	2003	2002	2003
Withoutsupplemental irrigation	2037	2571	38	2934	0.99	1.48
One supplemental irrigation	2673	3211	635	4214	1.09	1.46
Two supplemental irrigation	3168	3839	3427	6739	1.37	1.71
CD (P=0.05)Green manures	110	180	-	-	-	-
Sole crop	2317	2927	476	3709	1.04	1.46
Maize+sunnhemp	2804	3376	1854	5241	1.20	1.60
Maize+cowpea	2756	3319	1694	4937	1.18	1.58
CD (P=0.05)Nitrogen levels	151	90	-	-	-	-
0	2356	2917	154	2978	0.98	1.38
20	2630	2313	1378	4776	1.14	1.57
40	2890	3491	2615	6133	1.33	1.72
CD (P=0.05)	**96**	**121**	**-**	**-**	**-**	**-**

Table 4. Interaction effect of supplemental irrigation, green manure intercropping and nitrogen levels on grain yield (kg ha^{-1}) of maize in 2002

Treatments	N_0	N_1	N_2	IxC Mean
$I_{0-}C_0$	310	490	662	487
C_1	565	663	757	662
C_2	510	640	746	632
Mean	**462**	**598**	**722**	**594**
$I_{1-}C_0$	665	875	1055	865
C_1	966	1136	1266	1123
C_2	925	1095	1225	1082
Mean	**852**	**1036**	**1182**	**1023**
$I_{-2-}C_0$	940	1165	1408	1171
C_1	1330	1515	1725	1523
C_2	1280	1465	1675	1473
Mean	**1184**	**1382**	**1603**	**1389**
C x N				
C_0	638	843	1040	840
C_1	954	1104	1252	1103
C_2	905	1067	1215	1062
N Mean	**832**	**1005**	**1169**	**1002**

Treatments	SEd	CD (P=0.05)
I	33.8	94
C	32.1	70
N	31.0	63
I at C	53.7	146
I at N	48.7	133
C at I	55.5	121
C at N	54.3	114
N at I	54.7	111
N at C	54.7	111
N at IC	93.2	NS
C at IN	102.6	NS
I at CN	94.7	NS

Table 5. Interaction effect of supplemental irrigation, green manure intercropping and nitrogen levels on grain yield (kg ha^{-1}) of maize in 2003

Treatments	N_0	N_1	N_2	IxC Mean
I_0 C_0	637	845	1025	836
C_1	895	1053	1173	1040
C_2	825	983	1103	970
Mean	786	961	1101	949
I_1 C_0	1050	1298	1506	1285
C_1	1368	1576	1734	1559
C_2	1300	1540	1698	1513
Mean	1240	1472	1646	1452
I_2 C_0	1290	1580	1830	1567
C_1	1684	1914	2154	1917
C_2	1600	1913	2070	1887
Mean	1525	1809	2019	1784
C x N				
C_0	992	1241	1454	1229
C_1	1316	1514	1687	1506
C_2	1242	1485	1624	1450
N Mean	1183	1413	1588	1395

Treatments	SEd	CD (P=0.05)
I	32.4	90
C	36.7	80
N	41.9	85
I at C	47.8	130
I at N	42.2	115
C at I	61.0	133
C at N	57.1	120
N at I	69.0	140
N at C	69.0	140
N at IC	125.7	NS
C at IN	134.6	NS
I at CN	126.4	NS

treatment combinations,sunnhemp intercropping under two supplemental irrigations recorded higher grain yield of 1523 and 1917 kg ha^{-1}during 2002 and 2003 respectively (Table 4 and Table 5).

With regard to CXN interaction ,both sole and intercropping of green manures performed well at higher N level.The treatment combination of C1N2 registered higher grain yield of 1252 and 1687 kg ha^{-1} during 2002 and 2003respectively and it was on par with C2N2,which recorded 1215 and 1624kg ha^{-1}during 2002 and 2003 respectively (Table 4 and Table 5).

In IXN interaction,at all irrigation regimes ,higher level of N was superior in increasing the grain yield of maize.Among the treatment combinations,two supplmental irrigations (I2N2) with 40 kg ha^{-1} produced highest grain yield of 1603 and 2019 kg ha^{-1} during 2002 and 2003respectively,which was superior to all other treatment combinations in both the years(Table 4 and Table 5).

The interaction between IXCXN was not found to be significant in both the years.

Economics

The highest net return of Rs. 5777 ha^{-1} and B:C ratio of 1.59 and 1.94 were recorded by the treatment combination of two supplemental irrigation with sunnhemp intercropping and incorporation and application of 40 kg N ha^{-1} during 2002 and 2003 respectively. Two supplemental irrigation with sunnhemp intercropping and incorporation and application of 40 kg N ha^{-1} was found to be productive and economically viable in dry land maize under different rainfall situations.

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