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Influence of Maize - Legume Associations and Nitrogen Levels on Growth and Dry Matter Accumulation of Rainfed Maize*

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Studies were conducted at the research farm, Meerut University, Meerut in *Kharif* 1973 and 1974, to find out the effect of nitrogen and legume associations on growth and dry matter accumulation of rainfed maize. Growing of greengram, blackgram and cowpea has stimulating effect on maize growth and its dry matter accumulation. The effects of legume on growth of maize were more apparent at later stage of maize life cycle. Application of nitrogen was found essential for the better growth of maize grown either alone or in association with legumes. However the amount of nitrogen required for better growth depends upon rainfall distribution of two years.

Maize (*Zea mays Linn*) growth and its dry matter accumulation is probably more limited by the deficiancy of nitrogen than by that of any other nutrient. Considerable improvements in the general growth and dry matter accumulation of maize plants due to application of fertilizer nitrogen has been reported by several workers Saxena, (1962) and Gonske and Keeney; On the other hand Warburton (1915) has reported an additional growth of non-legumes when grown with legumes. Guljaev and Rousal (1963) concluded that the effect of legume association with non-legume was specific and root secretions of soybean and cowpea stimulated the growth of maize. However, work carried out on growth any dry matter accumulation of rainfed maize in relation to different rates of nitrogen when it is grown with legumes is meagre. Therefore, to findout the effect of nitrogen and legume associations on growth and dry matter accumulation of rainfed maize, the observations were made and data were collected on the leaf area index (LAI), relative growth rate (RGR) and dry matter accumulation at different growth stages of maize grown in association with different legumes at various nitrogen levels.

MATERIAL AND METHODS

The experiment was conducted in a randomised block design, with factorial concept, replicated four times at the research farm, Meerut University, Meerut during *Kharif* 1973 and 1974. The Soil (0—25 cm) was sandy

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clay loam (pH - 7.1, total N-0.046% and organic carbon 0.50%) with good drainage.

The treatment consisted of the combinations of six crop mixtures (C_1, maize pure; C_2, maize + greengram; C_3 maize + groundnut; C_4, maize + soybean; C_5, maize + blackgram and C_6, maize + cowpea) and three levels of nitrogen (40, 80 and 120 Kg./ha.) Half of the dose of nitrogen and full dose of P_2O_5 and K_2O were applied as basal. Remaining half nitrogen was side dressed to maize rows at knee-high stage. Maize was sown at a distance of 75 cm from row to row and 25 cm from plant to plant. One row of legume crop was sown in between maize rows. The plant to plant distance within the legume crop was 10 cm except for soybean which was sown at 5 cm distance only. The varieties used in the experiments were Ganga safed-2 maize; Type-44 greengram; Type-46 groundnut; Clark-63 soybean; Type-9 blackgram and Pusa Phalguni cowpea.

Leaf area per plant was calculated by Leaf product method viz. length x maximum width x factor 0.75 (Montgomery, 1911). Based on leaf area per plant the leaf area per plot was calculated and than leaf area index, which is the ratio of the total plant cover to the land area, was worked out. The rate of increase in dry matter weight per unit dry weight is known as suggested by Briggs *et al* (1920). The composite plant samples of various component parts were chaffed in to small pieces, thoroughly mixed, weighed for fresh weight and sub sampled for dry matter determination. The samples were placed in an electric oven at a constant temperature 95°C for an hour followed by drying at 65°C for 24 hours and weighed. Accumulation of dry matter in whole plant was worked out from dry weight and fresh weight data.

RESULTS AND DISCUSSION

Leaf Area Index (LAI)

The leaf area index (LAI), on the whole was lesser at knee high stage and increased markedly at silking stage thereafter, it decreased sharply in both the years (Table-I). Effect of legume associations on LAI of maize was found significant at knee high stage in 1974 and at maturity during both the years. At knee high stage, growing of maize with blackgram, cowpea and soybean favourably increased the LAI of maize over maize alone. At maturity stage in 1973, growing of maize with greengram and cowpea were found significantly superior in increasing LAI over maize alone, while in 1974 growing of maize with greengram and blackgram helped the maize plants in attaining higher LAI compared to maize when grown alone. The increase in LAI of maize when grown with legumes was on account of increase in number of functioning leaf and thereby increase in leaf area/unit area.

Application of 80 and 120 kg N/ha Increased LAI of maize significantly over 40 kg N/ha at different stages of maize growth during both the years except at silking stage during 1973, when 120 Kg N/ha level was also significantly superior over 80 kg. N/ha The increase in LAI with increase of nitrogen levels was due to the fact that the application of nitrogen increased the number of functioning leaves considerably as also reported by Nair (1962).

Relative Growth Rate (RGR)

The significant effect of maize - legumes associations on RGR values was recorded at later crop growth period from silking to maturity during both the years (Table-I). In 1973, growing of greengram and cowpea with maize was found to be significantly superior in increasing RGR values of maize compared to maize alone. In 1974, the RGR values were significantly higher when blackgram and cowpea was grown with maize compared to maize alone. The increase in RGR of maize when grown with legumes was due to the fact that the growing of legumes increased the photosynthesis capacity (LAI) of maize considerably.

Application of 80 and 120 Kg N/ha significantly increased RGR over 40 Kg N/ha throughout the growth period during both the years. However, 80 and 120 Kg N/ha levels were not significant among themselves except at early period of growth during 1974. The increase in RGR with the increase in nitrogen level was due to the fact that nitrogen plays a leading role in photosynthesis. With the increase in leaf area, photosynthesis increases which results better growth rate.

Dry Matter Accumulation

The total dry matter accumulation was slow from seedling emergence to knee high stage, it was rapid during the period from knee high stage to silking stage. Maximum total dry matter was attained at maturity because of grains.

The effect of maize - legume associations on total dry matter accumulation in maize was significant at maturity during both the years and at silking stage during 1974 only (Table II). In 1974, at silking, growing of maize with blackgram and greengram resulted significantly higher dry matter accumulation compared to maize alone. However, the differences were non-significant when maize was grown with other legumes like groundnut, soybean and cowpea. At maturity, growing of greengram and cowpea with maize was found helpful in increasing dry matter accumulation in maize compared to when it was grown alone during both the years. However, differences in contributions of legumes to dry matter accumulation in maize were more pronounced during 1973 compared to 1974 which was on account of differences in rainfall

distribution and growth of maize and legumes. The increase in dry matter accumulation in maize when grown with legumes may be due to stimulated effect of legumes through root secretions (nitrogen) on maize. Similar results has also been reported by Guljaev and Rousal (1963).

Application of 80 and 120 Kg N/ha significantly increased total dry matter accumulation per plant over 40 Kg N/ha at the stages of crop growth during both the years. The differences among the levels of nitrogen became more clear with advance in the age of crop. The difference between 80 and 120 Kg. N/ha level was non-significant among themselves at all the stages of growth during both the years except at knee high and silking stage during 1973. The increase in dry matter accumulation in maize was on account of beneficial effects of legumes and nitrogen levels on photosynthesis system (NAR) and capacity for photosynthesis (LAI).

It is seen that legumes like greengram, blackgram and cowpea in association with maize performed better which results better growth and dry matter accumulation of maize as compared to other legumes. This may be due to more excretion of nitrogen by these leguminous crops and beneficial effects on root growth of maize as already reported by Gangwar and Kalra (1978). The additional beneficial effects of legumes on maize growth may also be on account of soil moisture conservation and natura control of weeds. Warburton (1915) also observed additional growth of non-legumes when grown with legumes It was noted that the favourable effects of legumes on growth charactors of maize were more apparent at later stage of maize life cycle. This may be owing to release of surplus nitrogen from the root nodules of legumes at later stage for the utilization of maize..

The grain yield date (Table-III) also revealed that the contribution of legumes like greengram, blackgram and cowpea towards maize yield was comparatively higher than the groundnut and soybean. Maximum yield ofl maize was recorded when it was grown in association with cowpea and blackgram in 1973 and 1974 respectively. The variation in yield of maize in different cropping treatments from year to year was due to fluctuations in the growth of legumes on account of differences in climate of two years. The growing of legumes with maize did not show any significant increase in straw yield of maize. But, the growing of greengram, cowpea and blackgram with maize slightly increased the protein content in maize grain as compared to maize when grown with groundnut and soybean. The contribution of legumes to grain yield and protein content but not to stover yield clearly shows that the nitrogen secrations from legumes nodules has its beneficial effects on maize at later stage.

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The stover yield and protein content of maize grains was found to be significantly higher at 80 Kg N/ha level as compared to 40 Kg N/ha, but it was on par with 120 Kg N/ha level during both the years. Similar trend on grain yield of maize was also recorded during 1974. But, in 1973 the application of 120 Kg N/ha resulted significantly higher grain yield of maize over 80 Kg N/ha. In case of legumes it was seen that the mean yield of legumes decreased slightly with increasing levels of nitrogen. However, the reduction was not significant which was due to the proper placement of nitrogen (urea) with maize rows Therefore, the application of nitrogen was found essential for the better growth of maize. However, the quantity of nitrogen required depends upon the rainfall distribution of two years. In 1973, a dose of 120 Kg N/ha was sufficient. This was due to fact tha in 1974, the rainfall pattern was very erratic during crop growth period, which resulted in poor utilization of nitrogen by maize. There fore, 120 Kg N/ha failed to show its superiority over the lower dose of nitrogen.

It is concluded that when legumes like blackgram and greengram are grown with maize, nitrogen application about 80 Kg N/ha seems sufficient to affect maize crop favourably. But, the application of 120 Kg N/ha is required when maize is grown alone or with soybean (under poor nodulation condition). This clearly inticates that blackgram and greengram contribute more atmospheric nitrogen for the welfare of associated crop of maize as compared to soybean.

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TABLE I Influence of maize - lagume associations × nitrogen levels on IAI and RGR of maize at its different stages of growth.

Treatments	Leaf area Index						Relative growth rate (g)			
	Knee high		Silking		Maturity		From knee high to silking stage		From Silking to maturity stage	
	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974
Maize pure	0.82	0.25	1.85	1.01	0.72	0.49	0.684	0.475	0.367	0.028
Maize + greengram	0.88	0.26	1.96	1.09	1.01	0.61	0.703	0.500	0.420	0.034
Maize + groundnut	0.87	0.31	1.81	1.11	0.80	0.60	0.703	0.464	0.388	0.039
Maize + Soybean	0.79	0.33	1.74	1.08	0.89	0.58	0.711	0.475	0.390	0.031
Maize + blackgram	0.77	0.34	1.69	1.05	0.89	0.61	0.691	0.474	0.392	0.035
Maize + cowpea	0.78	0.35	1.92	1.09	1.07	0.49	0.747	0.481	0.417	0.032
SE ±	0.030	0.019	0.084	0.057	0.072	0.039	0.016	0.012	0.015	0.001
CD at 5%	NS	0.055	NS	NS	0.205	0.11	NS	NS	0.044	0.004
40 Kg N/ha	0.67	0.23	1.43	0.92	0.73	0.05	0.685	0.429	0.357	0.028
80 Kg N/ha	0.85	0.32	1.58	1.24	0 97	0.60	0.718	0.517	0.410	0.034
120 Kg N/ha	0.93	0.31	2.06	1.05	0.98	0.59	0.725	0.488	0.420	0.033
SE ±	0.026	0.013	0.059	0.040	0.051	0.145	0.011	0.008	0.010	0.001
CD at 5%	0.075	0.039	0.170	0.116	0.155	0.079	0.032	0.024	0.031	0.003

NS — Not Significant

TABLE II Influence of maize - legume associations and nitrogen levels on total dry matter accumulation (gm/plant) of maize at its different stages of growth.

Treatments	Stages					
	Knee high		Silking		Maturity	
	1973	1974	1973	1974	1973	1974
C_1 - Maize pure	10.3	4.3	55.9	48.7	214.1	121.8
C_2 - Maize + green gram	10.7	4.4	55.4	55.5	335.4	134.2
C_3 - Maize + Groundnut	10.2	4.9	59.1	49.4	212.9	119.8
C_4 - Maize + Soybean	10.4	4.4	56.5	52.1	215.4	123.9
C_5 - Maize + black gram	10.7	4.7	57.7	57.7	224.1	133.9
C_6 - Maize + Cowpea	10.1	4.2	55.6	52.5	335.6	125.6
SE ±	0.27	0.22	2.18	2.39	7.29	4.97
CD at 5%	NS	NS	NS	6.79	20.71	14.11
N_1 - 40 Kg N/ha	9.6	4.1	43.5	46.1	188.1	110.7
N_2 - 80 Kg N/ha	10.5	4.8	58.2	56.8	244.6	136.9
N_3 - 120 Kg N/ha	11.2	4.6	68.5	54.8	235.9	131.9
SE ±	0.19	0.15	1.54	1.69	5.15	3.51
CD at 5%	0.65	0.44	4.37	4.81	14.65	9.98

NS. Not Significant

At maturity dry matter includes grain yield/plant also.

TABLE III Influence of maize - legume associations and nitrogen levels on grain yield (maize and legumes), straw yield and protein content of maize

Treatments	Yield (Q/ha)						Protien content (%) of maize grains	
	Maize grain		Legume grains		Maize straw			
	1973	1974	1973	1974	1973	1974	1973	1974
Maize pure	15.17	12.96	—	—	48.78	27.87	8.81	10.13
Maize + green gram	19.70	16.00	3.60	5.30	53.26	29.08	8.96	10.98
Maize + groundnut	17.70	14.64	10.10	11.60	47.37	28.05	8.44	9.95
Maize + Soybean	15.71	13.35	5.10	2.50	51.58	32.24	8.39	10.26
Maize + black gram	17.47	15.89	4.40	8.30	47.88	30.49	8.89	10.39
Maize + Cowpea	19.33	13.95	3.60	6.20	49.13	28.97	9.22	10.89
SE ±	0.91	0.82	—	—	2.20	1.51	0.19	0.12
CD at 5%	2.59	2.33	—	—	NS	NS	0.54	0.35
40 Kg N/ha	12.84	11.47	5.61	6.29	40.18	26.48	8.02	9.53
80 Kg N/ha	17.81	16.53	5.60	6.27	55.54	32.28	9.12	10.61
120 Kg N/ha	21.92	15.41	5.03	6.13	53.27	29.64	8.99	10.63
SD ±	0.64	0.58	0.29	0.41	1.55	1.11	0.13	0.09
CD at 5%	1.83	1.65	NS	NS	4.42	3.15	0.38	0.25

NS - Not Significant.