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Dry Matter Partitioning and Harvest Index of Maize Crop as Influenced by Integration of Sheep Manure and Urea Fertilizer

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Abstract

The experiment was designed to evaluate the effect of sheep manure (SM), its application timing (AT) and N fertilizer (urea) on dry matter partitioning and harvest index. The study was conducted on RCBD split plots arrangement at Agronomic research farm during 2015. Sheep manure (SM1=3 t ha^{-1}, SM2=4 t ha^{-1}, SM3=5 t ha^{-1}) and application timing (AT1=15 days before sowing, AT2=At sowing time) were allotted to main plots however, fertilizer N (N1=0 kg ha^{-1}, N2= 90 kg ha^{-1}, N3=120 kg ha^{-1}) were applied to sub-plots. Application of 5 t ha^{-1} of sheep manure at 15 days before sowing signifcantly enhanced pre-tasseling (stem and leaves) and physiological maturity (stem, leaves, cobs and grains) dry matter partitioning and harvest index. Pre-tassel and physiological maturity dry matter accumulation were higher with application of 120 kg N ha^{-1} however, Application of 5 t sheep manure ha^{-1} at 15 days before sowing and 120 kg N ha^{-1} was recommended for higher dry matter accumulation of maize crop.

Maize (*Zea mays* L.) is the third most important crop in the world a er wheat and rice. It is a tropical crop but can be grown pro tably in subtropical and temperate climatic zones of the world during spring and summer season [1]. In Pakistan a er wheat and rice, maize holds the central position and is extensively cultivated (1.11 million hectares) in Punjab and Khyber Pakhtunkhwa [2]. In Pakistan satisfactory potential yield has not been achieved due to several limitations. e poor soil organic matter and imbalance fertilizer application are the important limitations, which limits plants growth, carbohydrate production and dry matter accumulation [3,4].

Dry matter production is basically a measure of plant photosynthetic and other essential nutrients for plants [19]. e use of organic matter positively in uences vegetative and reproductive growth of plants [20] and dry matter production [21]. Naturally available animal manure and plant residues can be used as an alternative cheaper source of synthetic fertilizers [22]. It provides nutrients to plants and adsorb essential nutrients such as Fe^{2+}, Mg^{2+} and NH^{4+}

$^{3-}$ which becomes avai Sheep manure contain high amount of primary macro nutrients

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application of sheep manure and urea fertilizer. Randomized complete block design with split plot arrangement was used with four replications. Sheep manure at the rate of 3, 4 and 5 t ha^{-1} and application timing at two levels (15 days before sowing, at sowing time) was allotted to main plots and fertilizer N at 3 levels (0, 90 and 120 kg ha^{-1}) was allotted to sub plots of size 5 m × 3.5 m. Sheep manure was incorporated in their respective plots 15 days before sowing and second treatment of SM was applied at sowing time, along with 90 kg N ha^{-1} (from SSP) and half of fertilizer N (urea). The second dose of N was applied at knee height of plant. Azam variety was sown on 19th June 2015 with the help of seed drill. Plant to Plant distance of 20 cm was maintained after proper thinning. Weed was removed from field with the help of hoeing. The crop was harvested at proper maturity and then sundried and threshed. Dry matter was calculated at two stages of crop growth that is given below.

Dry matter partitioning was recorded at pre-tasseling stage by randomly harvesting 1 m row from each sub plot. Harvested plants were divided into stem and leaves (leaf sheath+leaf blade), and these materials were oven dried at 70°C for 24 hours and their weights were recorded with the help of sensitive balance. At physiological maturity, dry matter partitioning was computed by harvesting 1 m long row selected randomly from each sub plot. The harvested plants were separated into stem, leaf, husk, grains, cobs and tassel. These materials were oven dried at 70°C for 24 hours and their weights were recorded.

The data was analyzed statistically with analysis of variance technique appropriate for RCBD split plots arrangement. Means was compared by LSD technique at 0.05 level of probability.

Results

Dry matter partitioning at pre-tasseling (g plant^{-1})

Data regarding dry matter partitioning in stem, leaves and total dry matter (TDM) at pre-tasseling is demonstrated in Table 1. Data analysis clarified that stem dry matter was significantly influenced by different sheep manure rates, its application time and N levels. Among various interactions only SM × N was found to have significant effects for pre-tasseling dry matter partitioning.

Sheep manure application of 5 t ha^{-1} amassed maximum stem, leaf and total pre-tasseling dry matter (10, 25.5, and 35.5 g plant^{-1}), respectively followed by 4 t ha^{-1} (9.9, 22.8, 32.7 g plant^{-1}), while lowest dry matter (8.9, 21.8, 30.8 g plant^{-1}) was noticed from plots receiving 3 t ha^{-1} sheep manure. Dry matter production is a function of nutrients availability and uptake by the plant [6], environmental and genetic factors [7]. At this stage higher dry matter were produced in leaves than stem. The higher dry matter accumulation in leaves and stem with addition of sheep manure might possibly since manure provides macro and micro nutrients to soil, improves soil properties and water use efficiency, better soil fertility might have increased the photosynthetic efficiency and partitioning of photo assimilates [25]. These findings are fully supported by Ayeni and Adetunji [26] who concluded that manure incorporation into the soil supply essential nutrients (N, P, K, Ca, Mg, Fe, Cu, Mn and Zn) to the maize crop, that resulted in maximum dry matter production with higher rates of manure. Greater dry matter (9.9, 24.6, 34.4 g plant^{-1}) was resulted from plots receiving sheep manure 15

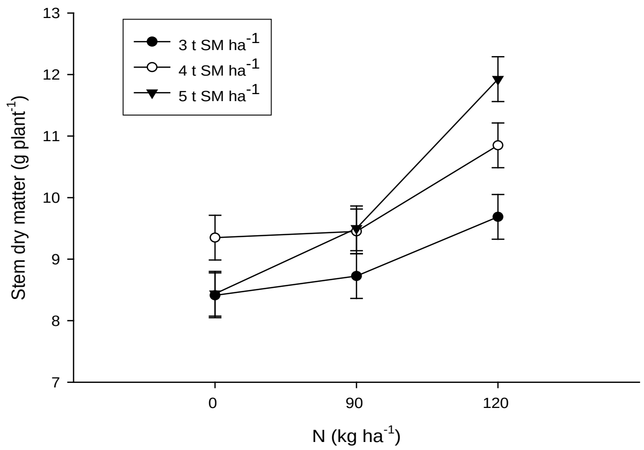

Stem dry matter (g plant-1)
N (kg ha-1)
3 t SM ha-1
4 t SM ha-1
5 t SM ha-1
13
12
11
10
9
8
7
0
90
120

Figure 1:

production from higher levels of sheep manure might be associated with more nutrients availability with higher amounts of sheep manure [19], improved soil aeration, water holding capacity, improved adsorption of calcium, magnesium, and potassium by forming clay humic complexes, and activities of soil microorganism [31], that might have improved plant growth [32], and photosynthetic production [25] and accumulated maximum dry matter. These finding are supported by Buriro [33] who observed higher dry matter production with increasing levels of manure. Likewise, with sheep manure incorporation 15 days before sowing higher dry matter was accumulated in stem, leaves, cobs, grains, and in whole plant (38.5, 32.9, 10.8, 56.8, 169.6 g plant^{-1}) than its application at sowing time (35.5, 31.1, 9.8, 52.3, 161.0 g plant^{-1}), respectively. This greater production of dry matter with sheep manure application before planting might be due to optimum mineralization of manure, and with more nutrients availability which might have helped in increasing root growth, water use efficiency and better soil fertility [34].

Nitrogen application of 120 kg ha^{-1} reckoned optimum dry matter at physiological maturity in stem, leaves, cobs, grains and whole plant (40.8, 34.3, 12, 61.6, 183.7 g plant^{-1}), which was higher than 90 kg ha^{-1} N (37.1, 32.0, 10.2, 54, 161.6 g plant^{-1}), while lowest dry matter (32.2, 29.7, 8.7, 48.1, 150.6 g plant^{-1}) was observed from control plots, respectively. Regarding husk optimum dry matter (13.2 g plant^{-1}) at physiological maturity was accumulated in plots receiving 120 kg N ha^{-1}, which was followed by 90 kg N ha^{-1} (11.7 g plant^{-1}), while lowest (9.9 g plant^{-1}) was observed from control. Maximum stem, leaves, cobs, grains, husk and total dry matter accumulation with higher rates of nitrogen might have the fact of its influence on vegetative growth of the plant, photosynthesis. These results are in accordance with the findings of Quansah, Ammanullah, and Nasim [34-37], who observed maximum dry matter production with increasing levels of inorganic fertilizer.

The data in Figure 4 (SM × N) showed no significant increase in stem dry matter accumulation with increasing N from 0 to 120 kg N ha^{-1}, at 3 t SM ha^{-1}. With changing N from 0 to 90 kg ha^{-1}, plots having 4 t SM ha^{-1} showed non-significant effect on dry matter accumulation, but higher sheep manure showed a marked increase with increase in N to 120 kg ha^{-1}. A strong increase was shown by 4 t ha^{-1} sheep manure with increasing N up to 120 over 5 tons SM ha^{-1}. From SM × N interaction (Figure 5) it is evident that with increase in N from 0 to 120 kg ha^{-1}. No apparent differences for leaf dry matter accumulation in plots having 5 t SM ha^{-1} were observed. However, with 3 and 4 t SM ha^{-1} the response was opposite, mean with increase in N increase in leaf dry matter was observed up to 90 kg N ha^{-1}, and with further increased the leaf dry matter accumulation was decreased. The interaction SM × N (Figure 6) showed that nitrogen increase from 0 to 90 kg ha^{-1} dry matter accumulation in cob increased across all the three levels of sheep manure, however with 3 t ha^{-1} sheep manure the increase was highest, and slighter with other two levels of sheep manure. The AT × M interaction (Figure 7) demonstrated that increasing SM incorporation from 3 to 4 t ha^{-1} no differences for grains dry matter partitioning were observed with its incorporation in plots at the time of sowing compared to increased grain DM when SM was applied 15 days before sowing. The further increasing sheep manure to 5 t ha^{-1} non-significantly differences for grains dry matter were observed whether it was used at the time of sowing or before sowing. The SM × N interaction (Figure 8) illustrated a linear increase in grains dry matter accumulation in 4 t ha^{-1} sheep manure treatment from 0 through 90 to 120 kg N ha^{-1}. While in plots received 3 t ha^{-1} grains dry matter increased but slightly decreased in 5 t ha^{-1} at nitrogen levels of 0 and 90 kg ha^{-1}, beyond 90 kg ha

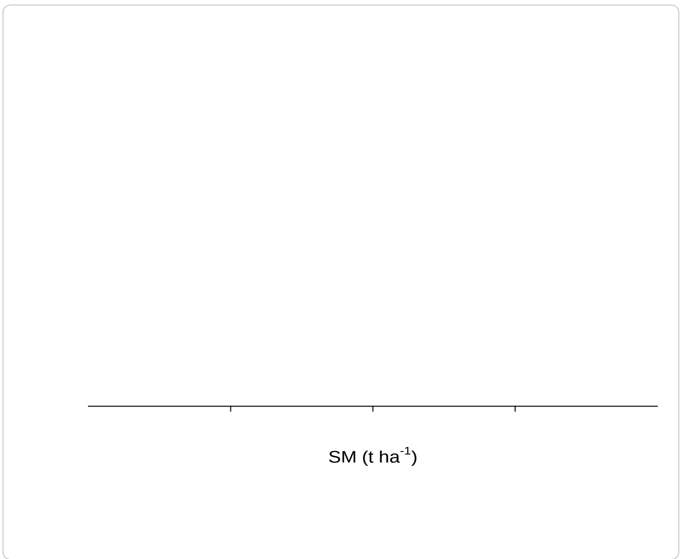
of sowing. e SM × N interaction (Figure 12) revealed that increasing N from 0 to 120 kg ha^{-1} had signi cantly increased harvest index (%) in plots having 3 t SM ha^{-1}. However, no signi cant increases in harvest index were observed with increasing N in plots having higher SM incorporation (4 to 5 t ha^{-1}). Higher harvest index recorded from SM application prior to planting, might be due to more nutrient uptake and higher dry matter portioning toward grain.

Conclusion

From the results, it was concluded that application of 5 t sheep manure ha^{-1} at 15 days before sowing and 120 kg N ha^{-1} produce more dry matter accumulation in terms of leaves, stem, cobs and grains.

Sheep manure (SM, t ha^{-1})	Application time of SM (AT, days)†	Nitrogen rates (N, kg ha^{-1})			SM × AT
		0	90	120	
3	15	26.2	36.3	39.3	33.9
4		27.9	33.4	35.2	32.2
5		38.6	34.5	38.9	37.3
3	0	27.3	33.2	29.3	29.9
4		35.7	31.4	37.8	34.9
5		33.7	32.6	36.4	34.2
	15	30.9	34.7	37.8	34.5
	0	32.2	32.4	34.5	33.0
3		26.7	34.8	34.3	31.9b
4		31.8	32.4	36.5	33.6ab
5		36.2	33.5	37.7	35.8a
Mean		31.6	33.6 ab	36.1 a	

†SM application was made 15 or 0 days before sowing



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