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Dry Matter Accumulation in Different Growth Stages of Maize (*Zea Mays (L.)*) Hybrids in Relation to Growing Degree Days

Keywords: *Dry matter accumulation, Growing Degree days, RBD, and Growth stages.*

Maize is the world's third most importantcereal crop after wheat and rice. The maize production in India stood at 22.13 million tonnes with an area of 9.2 million hectare during 2017-18. The total production is 4.23million tones with an area of 1.0 million hectare in Andhra Pradesh.(ICAR-IIMR Directors review 2016-17, New Delhi). Due to its more genetic diversity it can be grown over wide range of environmental conditions and canopy production, total dry matter (DM), and crop yield in diverse environments, for diverse genotypes. The dry matter yield or increase in kernel yield is mainly attributed to significantly higher kernel weight of the cob as well as total dry matter production and its partitioning in to different components (leaf, stem, root, cob and tassel) depends on its efficiency of photosynthetic rate ultimately. Omer (2005).Partitioning of dry matter in different plant parts influences the environmental factors , majorly accumulated temperature that expressed as growing degree days (Reumer 1735). Growing degree days (GDD) are used to measure corn growth stages relative to temperature. As Growing season progresses, daily Growing degree units are added together to obtain or define the stages of the maize crop in relation to accumulated dry matter (Lauer J, 1997).

The experiment was conducted in, Orchard block of the farm of Agricultural College, Bapatla. The farm geographically located on the eastern side of the peninsular India, situated at an altitude of 5.49m above mean sea level,$15^0$54' Northern latitude,$80^0$25'Eastern longitude and about 7 km away from Bay of Bengal in Agro-climatic Zone III of Andhra Pradesh. During the crop growth period in rabi 2016-17,the average temperatures ranges from 19.1 to 31.4 ^{0}C .The mean temperature of maximum and minimum used to calculate the growing degree days (GDD). During the growth period of maize the daily temperature variations were recorded since the crop inception in the field *i.e*; seed germination to cob harvest in the consequent crop growth seasons the coordinal temperature points are calculated by the expression of growing degree days (GDD). Growing degree days are an arthematic accumulation of daily mean temperatures above certain threshold levels, and the GDD was calculated by using the formula,

$$GDD = \frac{\Sigma \text{ (Max. Temp. + Mini. Temp.)}}{2} \text{ - Base Temp.}$$

Destructive growth analysis was carried out at every weekly interval from the demarked sampling area of each plot. Five plants were selected and pulled out and brought to the laboratory. These plants were separated into leaves, stem, root and reproductive parts. These plant parts were sun dried and later oven dried at 85 °C for three days to attain constant dry weight. The data was analyzed by following the analysis of variance (ANOVA) technique as suggested by Panse and Sukhatme (1978). The statistical hypothesis of equalities of treatment means was tested by the test in ANOVA at 5 percent level of significance to compare different treatment means.

Dry matter partitioning is most sensitive to values for parameters that described phonological development of genotypes and rates of leaf initiation and appearance, and thus radiation interception (Birch 1998). During *rabi* 2016-17 seedling stage, among all six maize hybrids no significant difference were found, and at 14DAS, the maize hybrids Pinnacle, DKC 9142, and DKC 9042 were recorded significant dry weights in plant parts like root, stem, leaves and total dry matter. At 21 DAS, Pinnacle and DKC 9142 were recoded its significant values in dry matter partitioning in all plant parts, but 900M Gold, DKC 9042 also elevated as significant hybrids in dry matter partitioning at 28DAS, the same tendency was carried even at 35 DAS, DKC 9142 and Pinnacle were recorded significant dry weight in root, stem and leaves, in leaf dry weight 900Mgold, DKC 9042 and DKC9120 followed the DKC 9142 and pinnacle. During 35 DAS, reproductive tissue was initiated in all six maize hybrids. The same trend was followed at 42 DAS in root and stem dry weight. At 56 DAS, in dry matter of stem, leaves, tassel and cob including total dry matter DKC 9142 (105.38 g) and Pinnacle (103.50 g) recorded significant dry weights and maximum tassel dry weight ranged from 3.73 to 4.58 g/plant at 56DAS were recorded At 63DAS, DKC 9142(V2) Pinnacle (V6)

continued its dominance in stem, leaves, tassel, cob and total dry matter .Significant values were recorded by DKC 9142 and Pinnacle in root, cob and total dry matter (274.75 g) respectively .Increasing trend was noticed in all plant parts i.e., root, stem, leaves ,cob and total dry matter except tassel at 77 DAS. After anthesis, shredding the pollen was the result of the recording lower dry weights in tassel after 63DAS. At 84DAS reduction in stem and leaf dry weights and increasing in cob and total dry matter observed, and the same trend was continued at 91DAS and harvest , attained maximum dry weights and DKC 9142 (161.88) followed by Pinnacle (160.50) and 900Mgold (156.25 and 290.0) in cob and total dry matter respectively.

Total dry matter was accelerated in rapid increment, DKC 9142 (220) recorded significantly more value of total dry weight at 63DAS, but at 70DAS, decreasing trend in stem ,leaf and tassel was observed, there is no significant difference were recorded and in root, cob and dry matter, Pinnacle (50.75,76.25,and 266.25) and DKC 9142 (50.25,77.75 and 264.25) respectively. Increasing in dry weight in cob and total dry matter was noticed in all six maize hybrids but significantly higher dry weights were recorded by Pinnacle (116.00 ,271.25) and DKC 9142 (115.52,271.75) in respective cob and total dry matter at 77 DAS. Dry matter in stem, leaves and tassel were recorded with little difference in constant, but rapid increment of dry matter was significantly noticed in Pinnacle (161.00 and 162.0), DKC 9142 (162.0 and 295.0) and 900Mgold (158.6 and 287.7) in cob and total dry matter respectively at 84DAS and until the harvest.

During vegetative growth, roots, stems and leaves are competitive sinks for assimilate. The proportion of assimilate partitioned to these three organs can influence plant growth and productivity. The investment of assimilate in to vegetative development results in increase in dry matter production (Gardener and Loomis 1953). Partitioning of assimilates to different plant parts influenced by the source(supply) and sink(demand) photosynthate and is moderated by vascular connections, storage capacity of non-grain tissues and competing demands for tissue nitrogen .Empirical evidence is that phloem transport can occur over large distances, but a sink is generally supplied from a nearby source .In maize , leaves above the cob generally supply the developing kernals, while leaves below the cob support the stem and root dry weight (Palmer *et al* 1973). Hence, during the vegetative development of the cropgrowing period, low values of dry weights in root, stem and leaves were recorded at 7DAS to 35 DAS in both the seasons. At 21DAS to 42 DAS, due to early vegetative growth by interception of more light energy for photosynthesis as it increased the dry matter production in root, stem and leaves. The time of reproductive tissue (tassel and cob differentiation) development influences the relationship between photosynthetic sources and growing sinks. In cereals generally, there is short period following germination when root is the major sink for seed reserves but in maize this dominance is lost by the forth leaf stage when the shoot is exposed to light and leaves photosynthesize enough for the plant to convert autotrophic growth. Tollenaar (1989) postulated a generalized functional balance between carbon assimilation by the shoot , nutrient and water absorption by the root during vegetative development . From 42DAS, After tasseling and silking in maize crop, the reproductive sink (ear) becomes extremely strong and sink size and activity expands, results the portioning of large amounts of their total dry matter into reproductive parts (ear),which limits the assimilates partitioned for the additional leaf, stem and root growth. The determinative cereal crops like maize vegetative parts dry matter accumulation was ceased in dry weight after reproductive development of the tassel and cob.

Dry matter production is basically a measure of plant photosynthetic efficiency with utilization of nutrient available and environmental factors. Leaves are the major source of dry matter production through photosynthesis, and then the accumulated and current assimilates partitioned as a function of developmental stage. The dry matter production depend on plant photosynthetic efficiency (source strength) and the sink capacity (sink strength) to accumulate the photosynthates from the source (leaf). The balanced nutrient provision increases the dry matter production and partitioning into various plant parts through its impact on source size (leaf area) and source activity (photosynthetic rate). At 56 DAS, plant leaf area and LAI showed its significant peak, Leaf area plays a key role in crop biomass production because it determines the amount of solar radiation intercepted by the crop and the amount of dry matter accumulated by a crop explains a large part of the yield variation. Therefore, progress in understanding crop production in response to the environment requires a quantitative understanding of leaf area development. Accurate prediction of the timing of leaf area development is essential to analyze and predict the responses of plants to the environment. For example, the determination of the beginning and the end of individual leaf development appeared central to the analysis and prediction of the eûect of environmental conditions such as soil water deûcit on leaf expansion in pea. During 63DAS anthesis and silking was completed in all six maize hybrids and plant growth stage was turned to reproductive peak at which all related parameters were considerable for dry matter partitioning.

Table 1. Total Dry Matter Production (g) of Six Maize Hybrids during 2016-17

HYBRIDS	7 DAS	14 DAS	21 DAS	28 DAS	35 DAS	42 DAS	49 DAS	56 DAS	63 DAS	70 DAS	77 DAS	84 DAS	91 DAS	Harvest
900MGOLD (T1)	0.38	1.05	2.63	4.96	5.75	7.94	38.14	96.75	210.75	247.50	281.48	289.63	289.63	289.63
DKC 9142 (T2)	0.39	1.17	2.84	5.45	6.46	8.81	39.66	105.38	234.75	274.75	296.75	299.50	299.50	299.50
DKC 9120 (T3)	0.38	1.12	2.62	4.64	5.86	8.43	38.32	92.75	211.25	252.75	274.25	274.00	274.00	274.00
DKC 9081 (T4)	0.38	1.14	2.63	4.35	5.57	7.88	37.34	90.75	211.25	247.25	270.75	269.00	269.00	269.00
DKC 9042 (T5)	0.39	1.14	2.67	4.98	5.87	7.95	38.92	92.25	218.00	249.25	274.25	276.75	276.75	276.75
Pinnacle (T6)	0.40	1.18	2.86	5.39	6.44	8.73	39.35	103.50	232.00	272.75	295.75	297.75	297.75	297.75
SEm±	0.09	0.01	0.06	0.02	0.07	0.16	0.92	2.82	4.60	3.11	4.87	5.09	5.09	5.09
CV%	3.67	1.40	3.55	11.03	1.85	2.74	3.40	4.12	2.96	1.71	2.44	2.53	2.53	2.53
CD(p=0.05)	NS	NS	0.14	0.62	0.16	0.34	1.98	6.02	9.81	6.64	10.39	10.86	10.86	10.86

Table 2. Dry Matter Partitioning (g) of Six Maize Hybrids during 2016-17

Hybrid	Harvest					
	Root	Stem	Leaves	Tassel	COB	Total
900MGold (V1)	49.98	40.63	40.70	1.83	156.25	290.23
DKC 9142 (V2)	53.08	41.98	40.95	2.03	161.88	300.50
DKC 9120 (V3)	49.38	37.70	39.73	1.73	145.43	275.20
DKC 9081 (V4)	49.25	34.53	39.50	1.55	144.63	274.00
DKC 9042 (V5)	50.25	36.00	39.50	1.83	149.38	277.15
Pinnacle (V6)	52.50	37.00	40.88	1.95	160.50	298.50
SEm±	3.87	2.96	1.23	0.14	4.26	5.10
CV%	10.81	11.05	4.33	11.28	3.94	2.54
CD(p=0.05)	NS	6.32	NS	0.3	9.09	10.89

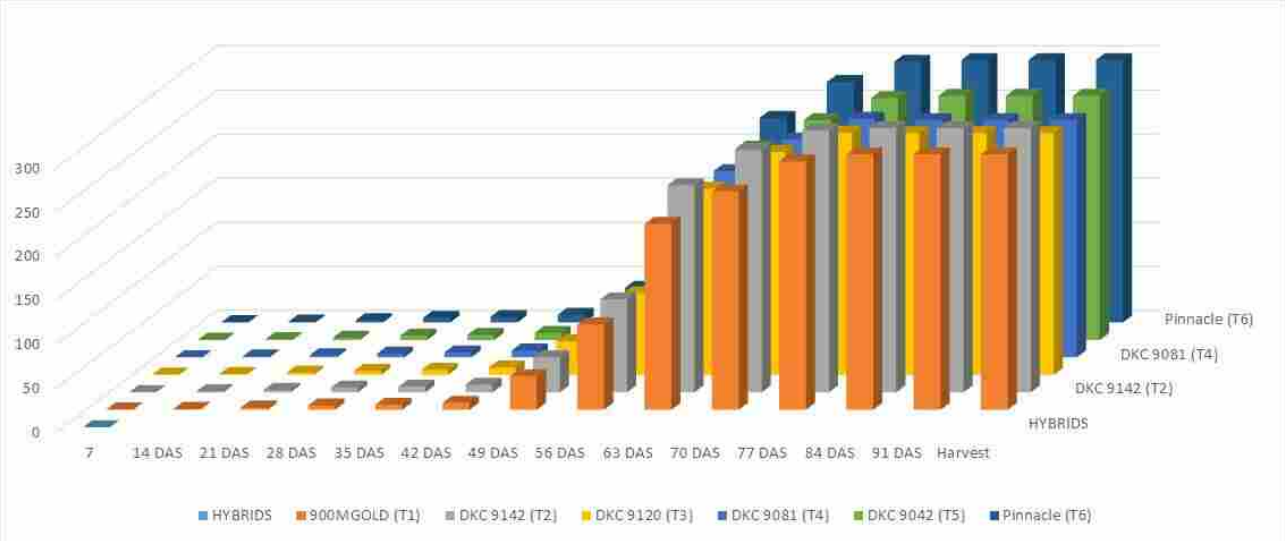

Fig 1.Total dry matter production of six maize hybrids during 2016-17

The general crop growth tendency of maize was observed during 63 DAS to 70 DAS in both the seasons of crop growth in all six maize hybrids. However, during the crop growth of both the seasons from 70DAS to 77DAS, assimilates are exported from the leaves and stems in the form of sucrose, during this stage leaf nitrogen and stem resources are remobilized continuously throughout kernel filling of the cob(Fisher and Palmer1984), from 70DAS to 84DAS, results that little reduction in stem and leaf dry weights were reduced till 84DAS.At 91 DAS the kernel was modified milk stage to dent stage until the black layer formation.

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