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Radiation use efficiency of maize hybrids as influenced by graded levels of nitrogen

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ABSTRACT

In order to study the effects of nitrogen levels on RUE of maize hybrids, a field experiment was conducted at college of agriculture, Navile, Shimoga during *kharif* of 2012 under rainfed conditions on sandy loam soil. The experiment was laid out in Factorial Randomized Complete Block Design with three replications. There were twelve treatment combinations comprised of two maize hybrids (SDH and LDH) and six nitrogen levels (0, 50, 100, 150, 200 and 150 kg N ha^{-1}). Results indicated that nitrogen levels had significant effects on RUE of maize hybrids. The higher cumulative leaf area index, PAR (1477.2 g MJ^{-1}), mean RUE (1.55 g MJ^{-1}) and grain yield (6327 kg ha^{-1}) was recorded at the application of 250 kg N ha^{-1} and it was on par with treatment which receives 200 kg N ha^{-1}. Treatment which receives 0 kg N ha^{-1} recorded significantly lower cumulative PAR (1035.0 g MJ^{-1}) and RUE (1.10). The higher cumulative PAR (1354.2 g MJ^{-1}), and RUE (1229.0 g MJ^{-1}), was recorded in the LDH compared to SDH. This might be due to higher leaf area index and leaf area duration of LDH resulted in better utilization of sunlight which leads to higher grain yield compared to SDH. In interaction effect the treatment which receives LDH and 250 kg N ha^{-1} recorded higher leaf area index (3.07), PAR (1530.0 g MJ^{-1}) and grain yield (6574 kg ha^{-1}).

Keywords: Maize hybrids, Photosyntheticaly active radiation (PAR), Radiation use efficiency and Yield.

1. INTRODUCTION

Successful in modern methods of better farming and breeding to reach a good yield partly is depend on management and use and distribution the light in a plant population.. If water and nutrient materials are enough to a plant, the light is only factor can have effective result on yield. All marks indicate that as light interception is much the yield will be more, through increasing light interception biological and economical yield is increased, but in grain yield economic increasing is more important than biological yield. Light is one of the main growth and biomass production factors in plant population and dry mater is a dependent from time and amount photosynthetic active radiation integrated received by plant, is a part of radiation absorbed by plant and is absorption light use efficiency and converted in dry mater. In farming plants that economic yield has particular important role on harvest index (HI) is added to above equal. Among factors mentioned amount of radiation available is not under the control of farmer and it is depending to latitude and elevation and regional atmospheric. Part of photosynthetic active radiation absorbs through plant, is dependent to leaf area index and Leafs decoration on plant canopy and leafs decoration on canopy is more important than leaf area index. Increasing leaf area index leads to more interception light, in plants have vertical decoration leafs radiation absorption is more effective this leaf decoration causes the light reach the bellow leafs on canopy and photosynthesis at bellow leafs of canopy at upper point compensation recompense point be protected.

Nitrogen is one of the first nutrient elements its deficiency is consider at arid and semiarid. Nitrogen effectiveness on agriculture productions depends to sun light radiation useful, leaf area index improve, leaf area duration, leaf emergence speed, lead to yield increase per unit and radiation use efficiency. Many researchers are believed while the nitrogen distribution pattern in canopy is similar to light distribution pattern, photosynthesis is on maximum.

This distribution pattern causes more nitrogen in leafs subject to light as though photosynthesis in leafs per leaf unit. Dreecer *et al.* reported that nitrogen content causes increase radiation use efficiency, leaf area extent and leaf area receiving radiation, nitrogen also applied in enzyme's structure that revival carbon dioxide. Vos *et al.*, indicated nitrogen fertilizer increased plant length, leaf numbers, leaf area index and light interception in maize plant. So the study of light influence effect and nitrogen amounts apply are the most elements on growth plant and yield grain, the object of this study is to the solar radiation use efficiency of maize hybrids as influenced by graded level of nitrogen.

2. MATERIALS AND METHODS

The present field trial was conducted on a sandy loam soil having available N of 213.25 kg ha^{-1}available phosphorus of 109.3 kg ha^{-1} and 171.36 kg ha^{-1} of available potassium at the Agronomic Research Area, college of agriculture, Navile, Shimoga during *kharif* 2012. The experiment was laid out in Factorial Randomized Complete Block Design with three replications. There were twelve treatment combinations comprised of two maize hybrids (SDH and LDH) and six nitrogen levels (0, 50, 100, 150, 200 and 150 kg N ha^{-1}). Net plot size was 3.6 m x 2.4 m. Seedbed was prepared by cultivating the soil 2-3 times with tractor mounted cultivator each followed by planking. Maize hybrids were sown @ 15 kg seeds per hectare in 45 cm between the rows and 30 cm between the plants on 30th July 2012 by dibbling. The amount of P and K (each 75 and 50 kg ha^{-1}, respectively) was remained constant in all the treatments. The sources of NPK in all the treatments were Urea, SSP (single super phosphate) and MOP (murate of potash), respectively. All P, K and 1/2 N according to respective treatment was applied at the time of sowing, 1/2 N was applied at 40DAS.Seven irrigation were given at different growth stages especially at seedling, knee high, tasselling, silking, and grain filling stage through surface irrigation. Thinning was done at 3-4 leaf stage to maintain a single plant at each hill. Crop was kept free of weeds by hoeing twice to avoid weed crop competition. All other agronomic practices were kept constant and uniform for all treatments. The crop was harvested on 3rd November 2012 for LDH (CP 818) and 25th October 2012 for SDH (Rajkumar), and standard procedures were followed to collect the data on growth and yield parameters.

The radiation interception by the crop canopy was worked out from the Bouguer- Lambert law is as follows.

The fraction of PAR transmitted through the community canopy,

$$I_L/I_O = T_n = \exp^{(-k \times LAI)}$$

Where I_L/I_O is the fraction of PAR transmitted through the canopy (LAI), k is light extinction coefficient, LAI = leaf area index of the canopy above light measurement. Light extinction coefficient was assumed to be 0.7 (Lindquist et al., 2005).

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Radiation Use Efficiency (RUE): It is defined as the amount of dry matter produced per unit of solar radiation or incoming PAR or intercepted PAR and expressed as g MJ^{-1} (Kiniry *et al*., 1989). RUE is worked out based on the following formula.

$$RUE = \frac{\text{Above ground biomass } (gm^{-2})}{\Sigma \text{ IPAR } (MJ\ m^{-2})}$$

Where, RUE = Radiation use efficiency ∑ IPAR is the cumulative intercepted PAR in MJ m^{-2} for a particular stage of the crop.

3. RESULTS AND DISSCUSSION

This research showed nitrogen levels had significant effects on, cumulative PAR, RUE and grain yield. Maize hybrids also had different response to these characteristics. The nitrogen importance on yield increase is related to profitable sun light uses, leaf area index improvement, leaf area duration and constant, leaf speed emergence and radiation use efficiency. Nitrogen fertilizer is one of the main factors on plant canopy holding and light absorption. Increasing radiation use efficiency affect nitrogen use efficiency and nitrogen supply in plant is important in light efficiency improvement.

Table 1: Grain yield, Stover yield and harvest index of maize hybrids as influenced by graded levels of nitrogen.

Hybrids / Nitrogen Levels	Grain yield (kg ha^{-1})			Stover yield (kg ha^{-1})			Harvest Index		
	SDH	LDH	Mean	SDH	LDH	Mean	SDH	LDH	Mean
0 kg N ha^{-1}	1244	1467	1355	2080	2343	2211	0.37	0.38	0.38
50 kg N ha^{-1}	2504	2784	2644	3982	4361	4171	0.39	0.39	0.39
100 kg N ha^{-1}	3468	3693	3581	5511	5735	5623	0.39	0.39	0.39
150 kg N ha^{-1}	4461	4856	4659	6944	7769	7356	0.39	0.38	0.39
200 kg N ha^{-1}	5752	6320	6036	8598	9291	8945	0.40	0.41	0.40
250 kg N ha^{-1}	6080	6574	6327	8840	9653	9247	0.41	0.41	0.41
Mean	3918	4282		5993	6525		0.39	0.39	
For Comparing	**SEm±**	**CD at 5%**	**CV (%)**	**SEm±**	**CD at 5%**	**CV (%)**	**SEm±**	**CD at 5%**	**CV (%)**
Hybrid (H)	68.3	200.4	10.07	118.6	348.0	8.04	0.005	NS	5.92
Nitrogen level (N)	118.3	347.1		205.5	602.7		0.009	NS	
H× N	167.3	NS		290.6	NS		0.013	NS	

Amount of cumulative PAR intercepted by maize was significantly influenced by nitrogen levels at all the growth stages. Higher amount of PAR intercepted by the plants receiving 250 kg N ha^{-1} (142.9 g MJ^{-1} to 1477.2 g MJ^{-1}), compared to other treatments. This variation in the PAR interception may be attributed to variation in canopy development. The

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amount of PAR is a function of leaf area index and leaf area duration. In turn LAI depend on leaf number per plant and leaf area per plant. Similar reported by Valero *et al.* (2005).

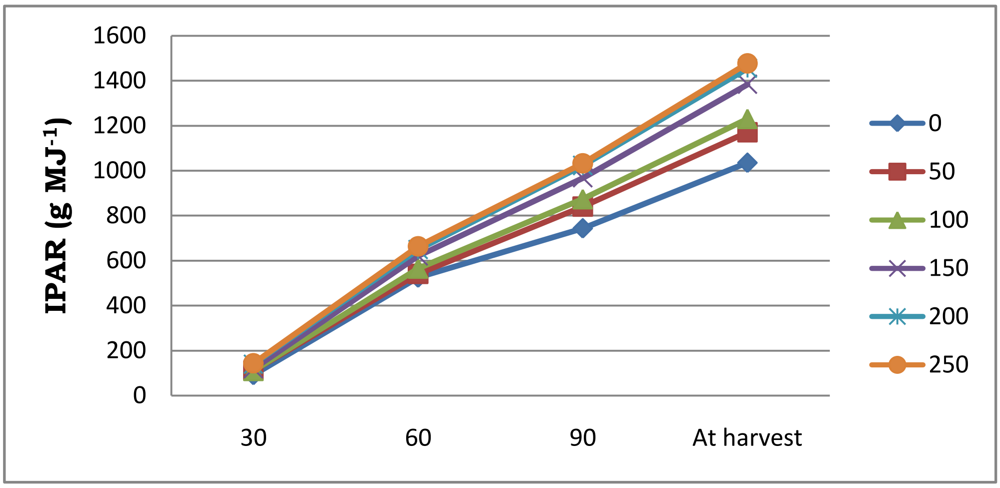

Fig: Intercepted photosyntheticaly active radiation of maize as influenced by graded level of Nitrogen

Application of nitrogen at 250 kg ha^{-1}(1.55 g MJ^{-1}) recorded higher mean RUE and that was on par with the treatment which receives 200 kg ha^{-1}(1.55 g MJ^{-1}).This might be due to difference in the light interception, increase in the leaf area and leaf area index these will leads to increased CGR and LAD higher biomass was also associated with higher RUE. These all are finely reflected on the higher RUE. These findings are in tune with the findings of Muchow and Davis (1998).

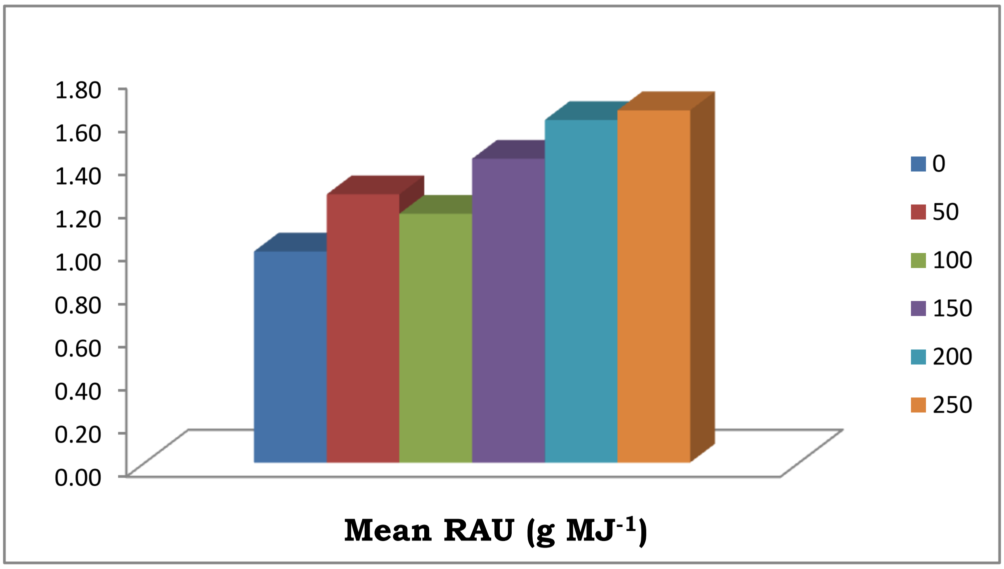

Fig : Mean RUE of maize as influenced by graded level of Nitrogen.

The present study involves six levels of nitrogen. Among six levels of nitrogen, application of nitrogen at 250 kg ha^{-1} recorded significant higher grain yield (6327 kg ha^{-1}) and it was on par with the treatment which received 200 kg N ha^{-1}

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(6036 kg ha^{-1}). There was an increase in the yield with increase of nitrogen. This could be attributed to the increased yield parameters like cob length, number of grains per cob, number of grain rows per cob, and test weight. Similar reports of increasing grain yield with increasing N level were reported by Ramachandra Prasad *et al* (1988); Shivay *et al* (2002) and Nagaraju (2006).

The increased PAR plays an important role in higher dry matter accumulation and grain yield. This increased PAR in LDH (124.0 to 1354.2 g MJ^{-1}) compared to SDH (114.3 to 1229.0 g MJ^{-1}) at all the growth stages due to higher leaf area, leaf area index and leaf area duration of LDH resulted in better utilization of sunlight compared to SDH. Radiation use efficiency was calculated using above ground bio-mass for different treatments. Significantly higher mean RUE was recorded in LDH (1.44 g MJ^{-1}) compared to SDH (1.32 g MJ^{-1}). This could be due to higher

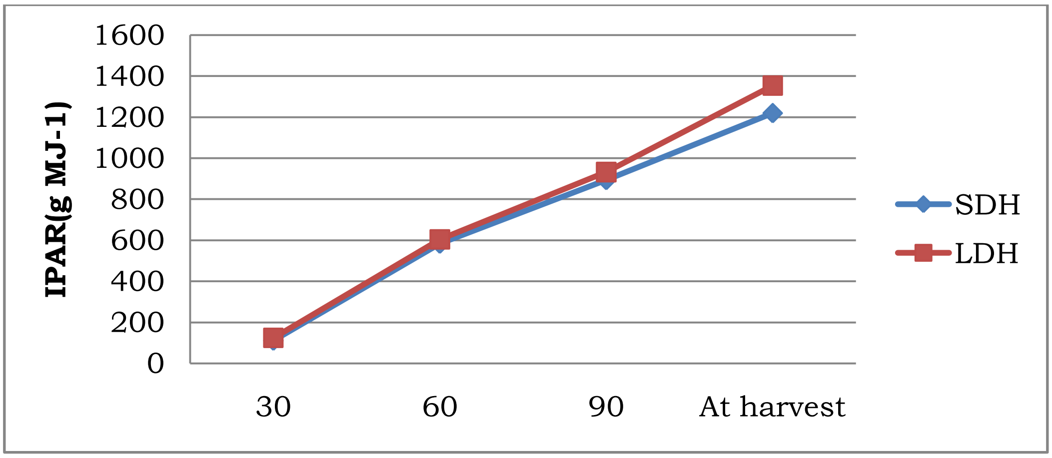

Fig : Intercepted photosyntheticaly active radiation as influenced by maize hybrids

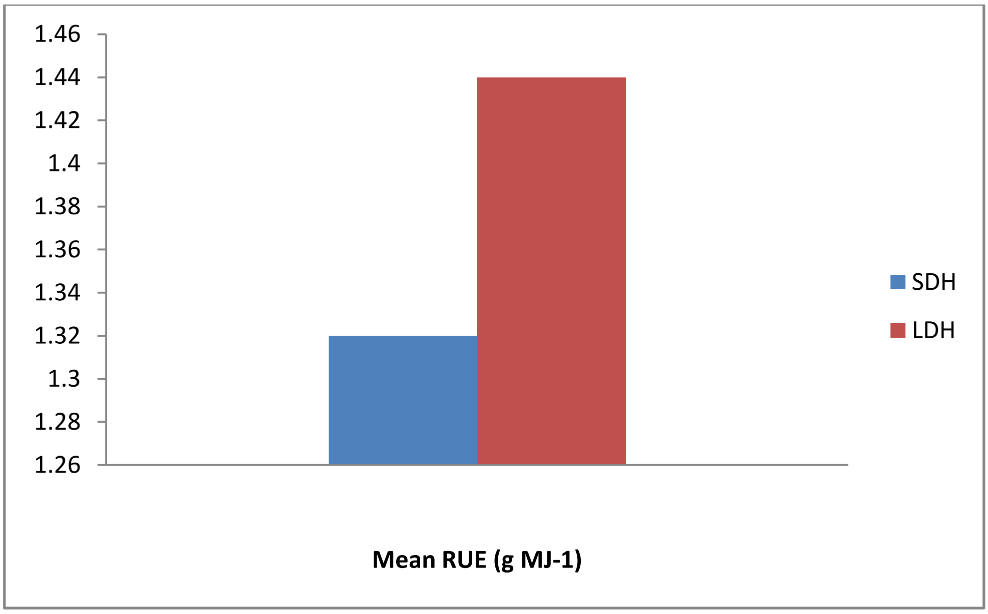

Fig : Mean RUE as influenced by maize hybrids

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PAR, leaf area index, CGR and LAD of LDH resulted in better utilization of sunlight. Croos.(1995) reported that hybrids had long filling period, had more leaf area and their yield grain had a correlation with their leaf area index, the hybrid S.C704 had more leaf area index, more light interception percentage and radiation use efficiency had more yield grain than other hybrids. The long duration hybrid (LDH) has recorded higher grain yield (4282 kg ha^{-1}) compared to short duration hybrid (SDH) (3918 kg ha^{-1}). The higher grain yield in the LDH may be attributed to increased yield attributes like cob weight, cob length, number of grains per cob, number of grain rows per cob, and test weight. These results are in agreement with the findings of Setty (1981); Sharifi and Taghizadeh (2009).

4. CONCLUSIONS

Considering all the results presented above, it can be concluded that, LDH performs better then SDH which out yielded with respect to higher grain yield, LAI, PAR and RUE. Grain yield and RUE showed an increasing trend up to the maximum levels of the N applied (250 kg N ha^{-1}). The N applied at levels greater than 200 kg ha^{-1} resulted in no additional response in terms of grain yield.

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