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Short Comminucation

Radiation interception and thermal requirement of wheat cultivars under Burma dek (*Melia composita* Willd.) in central Punjab

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The agroforestry is considered as one of the viable options for diversification in irrigated agro-ecosystem for economic upliftment of the farmers, in addition to conserving the natural resources. There is dire need to develop the economically viable tree-based cropping system to improve the total system productivity. Punjab state forest department has been making every possible effort to encourage *M. composita* commonly referred as Burma dek because of its fast growth, light crown and drought tolerant nature. Biomass and growth of *M. azedarach* was better when inter cropping with maize, turmeric, ginger than sole cropping (Vanlalhluna and Sahoo, 2009). Wheat is one of the most economical crops that can be successfully grown with dek due to its deciduous nature. Appropriate sowing times and improved cultivars are the pre-requisite factors for optimum production and play major role especially in influencing grain production (Amrawat *et al.,* 2013). Tree growth characteristics affect the light, temperature and humidity within the plantation. Therefore, differential response of wheat cultivars was expected under reduced light conditions under dek block plantation. As light intensity governs the crop phenological development and the efficient conversion of biomass into economic yield. The present study was planned to find out the compatible wheat cultivar along with their optimum sowing time that can be intercropped with dek block plantation for increasing the total system productivity. Agroclimatic models based on thermal indices can play an important role in predicting growth and yield of crops. Attempts have been made by different workers to predict phenology, growth and yield of sole crops (Hundal *et al.,* 2003**)** and crops intercropped with poplar trees (Gill *et al*., 2016).

The present investigation was carried out at the experimental area of the Department of Forestry and Natural Resources, Punjab Agricultural University, Ludhiana, during the year 2015-2016 to evaluate growth and yield of four wheat cultivars (HD 2967, WH 1105, PBW 677 and PBW 725) sown on three dates (25th October, 10th November and 25th November) under 3 years old dek plantation as well as open conditions. The wheat crop was sown between dek trees planted at 7×3 m spacing. The net plot size was 5 × 3 = 15 m^2. The experiment was laid out in split-split plot design with three replications. The environment (dek and open) was kept in main plot and time of sowing in sub plot and wheat varieties in sub-sub plot. The wheat cultivars were raised following the recommended package of practices for *rabi* crops of the Punjab Agricultural University, Ludhiana. The crop under tree as well as under open condition was managed in similar way. The crop received 100 kg N ha^{-1} (urea) and 30 kg P_2O_5 ha^{-1} (single super phosphate). At sowing, one half of the nitrogen and all P_2O_5 were applied as basal dose. The remaining half dose of nitrogen was applied with first irrigation.

The growing degree days (GDD) was determined as per Nuttonson, (1955) by assuming base temperature of 5°C. Growing degree days (GDD) were accumulated from the date of sowing to each phenological date for estimating accumulated GDD. Photothermal units (PTU) i.e. the product of GDD and corresponding day length for that day were computed on daily basis. Photothermal units (PTU) were accumulated from the date of sowing to each phenological stage for accumulated PTU. Heat use efficiency (HUE) for seed and straw yield were computed for comparing the relative performance of different wheat cultivars and treatments with respect to utilization of heat using following formula:

Heat use efficiency (HUE) = Total yield (kg ha^{-1})/Accumulated GDD (°C day)

PAR and phenological observations

The data on photosynthetically active radiation was recorded at 15 days interval under open and shade conditions separately (Fig 1). It was observed that PAR was recorded higher in open conditions as compared to dek

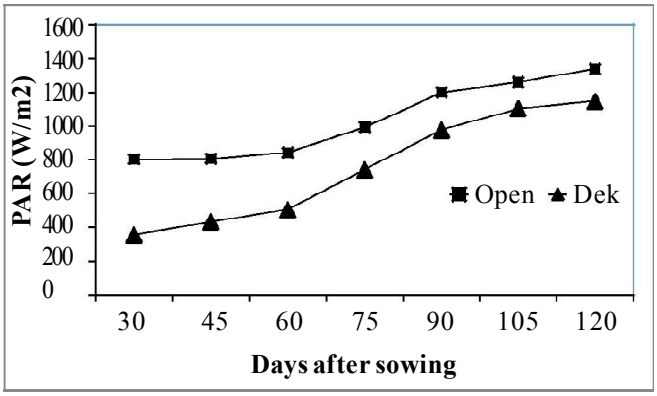

Fig 1. Photosynthetically active radiation (Watt m^{-2}) recorded during the wheat growing season under dek and open conditions (*rabi* 2015-16)

Table 1: Mean phenological stages acquired by wheat under dek and open conditions during *rabi* 2015-16.

Phenological stages	Days taken	
	Under dek	Open
Emergence	6.7 ± 0.6	6.0 ± 0.0
CRI	20.7 ± 1.5	20.0 ± 1.0
Tillering	36.7 ± 3.1	34.0 ± 1.0
Flag leaf	82.3± 2.1	80.7 ± 1.5
Booting	92.7 ± 2.5	91.3 ± 2.1
Heading	101.0 ± 3.6	99.3 ± 4.0
Milking	119.3 ± 5.7	117.7 ± 6.1
Maturity	146.3 ± 8.5	144.0 ± 9.0

block plantation. The PAR interception between dek and open plantation has been averaged out to be nearly 17 per cent being higher in open conditions. Shading always reduces crop growth rate in direct proportion to canopy size. During March–April, dek leaves start sprouting and by this time wheat crop enters into maturity. Hence shading by dek leaves decreases the light intensity and ultimately it becomes one of the limiting factors for the decline in grain yield of wheat grown under dek than open. Similar results were observed by Thakur and Singh (2002) in the case of *Morus alba*, in which 75 per cent canopy removal allowed more light transmission as compared to 0, 25 and 50% canopy removal.

The average number of days taken to attain physiological maturity was 146.3±8.5 under dek plantation and 144.0±9.0 days under open conditions (Table 1). It has been observed that the physiological maturity has been delayed by only 2-3 days under dek due to less canopy

Table 2: Effect of environment, time of sowing and varieties on yield of wheat during crop season (*rabi* 2015-16)

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Environment		
Dek	4121	7542
Open	5243	8454
LSD (p=0.05)	440	842
Sowing dates		
25th Oct.	4900	8280
10th Nov.	4803	8150
25th Nov.	4354	7650
LSD (p=0.05)	173	313
Cultivars		
HD 2967	4552	7981
WH 1105	4605	7684
PBW 677	4673	8170
PBW 725	4910	8293
LSD (p=0.05)	264	442

spread by 3 year old dek trees planted at wider spacing.

Agroclimatic indices, grain yield and heat use efficiency (HUE)

The crop performance was significantly influenced by the environment. There was reduction of 21.4% in average wheat yield intercropped with 3 years old dek block plantation irrespective of the treatments as compared to open (Table 2). Gill *et al*., (2009) reported that wheat yield decreased under poplar plantation due to lower production of photosynthates as the light intensity decreased under trees. The accumulated growing degree days by wheat cultivars was less (1680±122 °C days) under dek in comparison to open (1795±142 °C days) condition, although the duration under dek was more. This was due to lower PAR and temperature under dek shade. Similarly, the APTU was also lower under dek shade in comparison to open condition (Table 3).

Heat use efficiency (HUE) wheat grain and straw yield were also higher under open condition in comparison to shade condition. This was mainly due to higher yields obtained under open conditions (Table 3). Grain and straw yield were higher in 25th October (4900 & 8280 kg ha^{-1}) sowing, which was statistically at par with 10th November

Table 3: Accumulated growing degree days (AGDD), accumulated photothermal units (APTU) and heat use efficiency (HUE) of wheat under open and shade conditions during crop season (*rabi* 2015-16)

Parameters	Under dek	Open
AGDD (°C day)	1680 ±122	1795 ±142
APTU (°C day hr)	18037 ±1460	19257 ±1681
Grain yield HUE (kg ha^{-1}°C day^{-1})	2.4 ±0.1	2.9 ±0.2
Straw yield HUE (kg ha^{-1}°C day^{-1})	4.5 ±0.1	4.7 ±0.2

(4803 & 8150 kg ha^{-1}) and significantly higher than 25th November (4354 & 7650 kg ha^{-1}) sowing (Table 2). Delayed sowing also affects the vegetative growth of plants which might be due to the temperature differences at the time of maturity resulted in reduced grain development period and ultimately yield. It showed that under both the environments the optimum period to get higher grain yield of wheat is from 25th October to 10th November. Among varieties, highest grain yield was obtained in PBW 725 (4910 kg ha^{-1}) being at par with PBW 677 (4673 kg ha^{-1}) but significantly better than WH 1105 (4605 kg ha^{-1}) and HD 2967 (4552 kg ha^{-1}) during the period under study. The grain yield of wheat cultivars was significantly higher under open than dek, therefore, the highest grain yield HUE of 2.9 kg ha^{-1}°C day^{-1} was recorded in open conditions and 2.4 kg ha^{-1}°C day^{-1}under dek for cv. PBW 725 in 10th November sown crop. Similarly, highest straw yield HUE of 4.7 and 4.5 kg ha^{-1}°C day^{-1} for cv. PBW 725 under open and shade conditions.

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