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Research Article

Effect of canopy temperature on growth and yield of pigeonpea + kalmegh intercropping system

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Abstract : A field experiment was conducted at Nagarjun Medicinal Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 2009-10 to determine suitable row proportion for pigeonpea + kalmegh intercropping system. Canopy temperature showed decreasing pattern with the advancement in age of the crop. Maximum thermal use efficiency (TUE) in pigeonpea and kalmegh was noticed with 2:1 (3.43 kg/ha/D^{0}C) and 1:1 (0.72 kg/ha/D^{0}C) row proportion. Dry matter and grain yield of pigeonpea recorded positive and negative correlation, respectively with canopy temperature. While, herbage yield, seed yield and andrographoloide yield of kalmegh recorded positive correlation with morning canopy temperature and negative correlation with evening canopy temperature.

Key Words : Kalmegh, Intercropping, Canopy temperature, TUE, Correlation

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INTRODUCTION

Kalmegh (*Andrographis paniculata* Wall. ex Nees) belong to family Acanthaceae, is an important annual medicinal herb widely distributed in plains throughout India and Shrilanka (Patra *et al.,* 2004). It consists of 40 species out of which 21 are in India. It is referred by different vernacular names like Charayetah, Kiryat, Mahatita, Bhuneemb and Kalmegh in different group of people in India (Amminuddin *et al.,* 1997). Medicinal plants have higher demand and high value in the market and are quite suitable to our soils and weather conditions. Indian farmers have been looking for some better alternative to diversify from traditional agriculture due to gradual reduction in profitability owing to decline in productivity, increased incidence of disease and pest in traditional crops. Medicinal plants' inclusion in cropping system is a better option. Pigeonpea being a predominantly rainfed crop of this region can be grown as component crop with kalmegh. On this line an experiment was conducted to assess the suitable row proportion for pigeonpea + kalmegh intercropping system and to study the impact of climate on productivity of this system.

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EXPERIMENTAL METHODS

A field experiment was conducted at Nagarjun Medicinal Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during 2009-10, so as to assess row proportion for pigeonpea + kalmegh intercropping system. The soil of experimental field was medium black.

The experiment was laid out in Randomized Block Design with four replications. The six treatments which include four intercropping row proportions (1:1, 2:1, 2:2 and 4:2 of pigeonpea and kalmegh) and sole crop of pigeonpea and kalmegh. Both the crops were sown at 45 cm row spacing and other packages were followed as per crop need and recommendations. The growth observations, yield attributes and yield of both crops were recorded at periodical intervals. The temperature of crop canopy was recorded at morning and evening at various growth stages with Digital TH meter (Digital thermohygrometer). Canopy temperature was correlated with dry matter, yield of pigeonpea and kalmegh and also with andrographoloide yield. Thermal units for each calendar day during the crop period for all the treatments were calculated from daily weather data on maximum and minimum temperatures as under :

$$\text{Thermal units (Tu)} = \frac{\text{Tmax} + \text{Tmin}}{2} - \text{T base}$$

Total thermal units over crop period under each treatment were calculated by summation for calculating thermal requirement of the crop over total growth period.

Thermal use efficiency of crop in terms of yield was worked out in all the treatments by dividing yield by respective thermal units.

$$\text{Thermal use efficiency (kg/ha/ D}^0\text{C) of yield} = \frac{\text{Yield (kg ha}^{-1}\text{)}}{\text{Thermal requirement (D}^0\text{C)}}$$

EXPERIMENTAL RESULTS AND ANALYSIS

The results obtained from the present study have been discussed in detail under following heads :

Canopy temperature:

Pigeonpea:

Data depicted in Table 1 indicated that the canopy temperature was maximum in sole pigeonpea during sowing to seedling and seedling to branching stage and further it was maximum in 1:1 row proportion during branching to flower initiation, flower initiation to pod initiation and pod initiation to grain development stages. This may be due to better light interception in 1:1 row proportion.

Kalmegh:

Data depicted in Table 2 indicated that the canopy temperature of kalmegh was found to be varied due to various row proportions. The maximum value of evening and morning temperature was observed in 2:1 row proportion during sowing to seedling stage, flower initiation to pod initiation and pod initiation to grain development. However during seedling to branching and branching to flower initiation the maximum canopy temperature was observed in 1:1 row proportion.

Thermal use efficiency:

Pigeonpea:

Thermal use efficiency in terms of biological yield and grain yield of pigeonpea as influenced by various row proportions (Table 3) indicated that the pigeonpea + kalmegh 2:1 row proportion was more efficient to produce maximum thermal use efficiency in terms of biological yield (3.43 kg/ha/D^{0}C) and grain yield (0.47 kg/ha/D^{0}C). This has resulted into higher seed yield of pigeonpea.

Kalmegh:

The sole kalmegh recorded maximum thermal use efficiency (0.72 kg/ha/D^{0}C) followed by 1:1 row proportion (Table 4) which indicated that sole kalmegh was more efficient to utilize maximum thermal energy. The less TUE in intercropping was due to shading effect of pigeonpea on

Table 1 : Mean canopy temperature (°C)of pigeonpea as influenced by various row proportions

Treatments	Sowing to seedling stage		Seedling to branching stage		Branching to flower initiation		Flower initiation to pod initiation		Pod initiation to grain development	
	Tevening	Tmorning	Tevening	Tmorning	Tevening	Tmorning	Tevening	Tmorning	Tevening	Tmorning
Pigeonpea : kalmegh (1:1)	34.35	33.40	33.63	32.73	32.95	32.30	31.23	29.95	29.00	27.93
Pigeonpea : kalmegh (2:1)	34.30	34.85	33.55	33.45	32.78	32.33	30.08	30.00	29.10	28.28
Pigeonpea : kalmegh (2:2)	34.38	33.18	33.68	32.93	32.95	33.03	30.90	30.03	29.18	28.58
Pigeonpea : kalmegh (4:2)	34.48	33.93	33.68	32.80	32.73	32.10	30.50	30.10	28.48	28.08
Sole pigeonpea	34.60	33.50	33.70	32.98	32.58	33.00	30.95	30.25	28.75	28.20
C.D. (P=0.05)	NS	1.58	NS	NS	NS	NS	078	NS	0.61	NS
Mean	34.42	33.77	33.65	32.98	32.80	32.55	30.73	30.07	28.90	28.21

NS=Non-significant

Table 2 : Mean canopy temperature (ºC)of kalmegh as influenced by various row proportions

Treatments	Sowing to seedling stage		Seedling to branching stage		Branching to flower initiation		Flower initiation to pod initiation		Pod initiation to grain development	
	Tevening	Tmorning	Tevening	Tmorning	Tevening	Tmorning	Tevening	Tmorning	Tevening	Tmorning
Pigeonpea : kalmegh (1:1)	34.40	34.30	33.63	32.78	32.93	31.65	30.88	29.40	28.88	27.93
Pigeonpea : kalmegh (2:1)	34.70	34.33	33.60	33.13	32.68	32.10	30.80	30.18	29.18	28.50
Pigeonpea : kalmegh (2:2)	34.48	33.83	33.45	32.70	32.70	32.25	30.98	29.90	29.18	28.33
Pigeonpea : kalmegh (4:2)	34.48	34.30	33.50	32.95	32.63	31.98	30.40	29.95	28.35	28.25
Sole kalmegh	34.35	34.33	33.63	33.23	32.68	32.98	30.95	30.43	28.65	28.65
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	0.81	NS
Mean	34.48	34.22	33.56	32.96	32.72	32.19	30.80	29.97	28.85	28.33

NS=Non-significant

Table 3 : Thermal use efficiency (TUE) in terms of biological yield and grain yield of pigeonpea

Treatments	Thermal requirement (DºC)	Biological yield (kg ha^{-1})	Grain yield (kg ha^{-1})	Thermal use efficiency (kg/ha/DºC)	
				Biological yield	Grain yield
Pigeonpea : kalmegh (1:1)	2883.21	7633.28	837.13	2.65	0.29
Pigeonpea : kalmegh (2:1)	2883.21	9888.79	1342.88	3.43	0.47
Pigeonpea : kalmegh (2:2)	2883.21	7488.83	1047.45	2.60	0.36
Pigeonpea : kalmegh (4:2)	2883.21	8847.13	1222.65	3.07	0.42
Sole pigeonpea	2883.21	9494.80	1219.55	3.29	0.42
Mean	2883.21	8670.57	1133.93	3.01	0.39

Table 4 : Thermal use efficiency (TUE) in terms of biological yield and seed yield of kalmegh

Treatments	Thermal requirement (DºC)	Biological yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Thermal use efficiency (kg/ha/DºC)	
				Biological yield	Seed yield
Pigeonpea : kalmegh (1:1)	3603.51	840.49	32.05	0.23	0.01
Pigeonpea : kalmegh (2:1)	3603.51	369.68	19.13	0.10	0.01
Pigeonpea : kalmegh (2:2)	3603.51	701.46	33.80	0.19	0.01
Pigeonpea : kalmegh (4:2)	3603.51	400.92	28.93	0.11	0.01
Sole kalmegh	3603.51	2586.66	87.05	0.72	0.02
Mean	3603.51	979.84	40.19	0.31	0.012

Table 5 : Correlation of dry matter (DM) and grain yield (GY) of pigeonpea with canopy temperature

	DM	GY	Teve	Tmor
DM	1			
GY	0.47142*	1		
Teve	-0.14104	0.17449	1	
Tmor	-0.00328	0.12735	0.27555	1

kalmegh.

Among pigeonpea and kalmegh, TUE of pigeonpea was more compared to kalmegh. This may be due to genetic potential of crops to absorb more energy and convert into biomass production. Similar observation in different varieties of soybean was reported by Sakarkar (2000).

Table 6 : Correlation of herbage yield (HY), seed yield (SY) and andrographoloide yield (AY) of kalmegh with canopy temperature

	HY	SY	AY	Teve	Tmor
HY	1				
SY	0.93128**	1			
AY	0.99702**	0.93730**	1		
Teve	-0.09699	-0.17453	-0.10836	1	
Tmor	0.21023	0.20892	0.23481	0.17066	1

** indicates significance of values at P=0.01

Correlation studies:

Pigeonpea

The dry matter and grain yield of pigeonpea was correlated with Teve, Tmor, which found positively correlated with grain yield and negatively correlated with dry matter. The grain yield was more positively and significantly correlated with dry matter production (Table 5).

Kalmegh:

The data presented in Table 6 indicated that the herbage yield of kalmegh was positively correlated with morning canopy temperature and negatively correlated with evening canopy temperature. Highly significant and positive correlation was observed with seed yield and herbage yield. The andrographoloide yield was positively correlated with herbage and seed yield. It shows that there was a positive relationship of andrographoloide yield with total dry matter accumulation. Similar results were recorded by Patel *et al.* (2000) in pigeonpea crop.

Conclusion:

Intercropping of kalmegh and pigeonpea with different row proportion was found to be more efficient to utilize natural resources such as canopy temperature, which was reflected to produce maximum biological yield, seed yield and maximum thermal use efficiency. Thus, it can be inferred that the pigeonpea + kalmegh intercropping was more feasible and economical either in 2:1 or 4:2 row proportions.

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