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RESEARCH PAPER

Effect of foliar fertilization of soluble fertilizer and times of sowing on the crop growth and yield of greengram in rainfed vertisols

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Abstract : The field experiments were conducted during 2011-12, 2012-13 and 2013-14 in *Rabi* season (October - January) at Agricultural Research station, Kovilpatti, Tamil Nadu to study the response of greengram to foliar fertilization and different times of sowing under rainfed situation. The results of the experiment revealed that sowing during 39th standard week registered increased growth and yield parameters *viz.*, DMP, LAI, number of pods/plant, pod length, number of seeds/pod which reflected on increased grain yield. Significantly lower grain yield was recorded by seeds sown in the 43rd standard week. Similarly among the foliar spraying of different soluble ferilizer and biofertilizer tried, seed treatment with *Rhizobium*, PSB and *Methylobaterium* (600 g/ha each) and foliar application of *Methylobaterium* (2 ml / lit) on 30 and 45 DAS (F_7) recorded significantly increased growth and yield attributes and yield of the crop which was followed by seed treatment with *Rhizobium* and PSB (600 g /ha each) + 2% KCL + 100 ppm boric acid foliar spray on 30 and 45 DAS (F_6).

Key Words : Dates of sowing, Foliar fertilization, Greengram, *Methylobacterium*, Yield

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INTRODUCTION

Greengram is one of the major pulse crops and it serves as an important protein source of our Indian diet. It gives low yield mainly due to poor management and low soil fertility. The productivity gap analysis revealed that the national average yield of greengram is 413 kg ha^{-1} as against 667 kg ha^{-1} in Punjab. This shows that there is a wide scope for increasing the productivity of greengram by proper management practice (Sathyamoorthi *et al*., 2013). Sowing time is one of the major non-monetary inputs affecting the growth and yield of field crops. Optimum time of sowing of mungbean may vary from variety to variety and season to season due to variation in agro-ecological conditions. Dudhat and Asodaria (2012) reported that higher seed yield in early sowing might be due to prevailing favorable climatic conditions in early monsoon sowing. The seed and stover yield of niger decreasing significantly for every 15 days

delay in sowing of niger crop from 15th November to 30th December (Mili *et al*., 2012).

Application of fertilizer under rainfed condition at right time and right quantity may not be efficient due to soil moisture. Foliar application of nutrients using water soluble fertilizer is one of the possible ways to enhance the productivity of greengram. Kuttimani and Velayutham, (2011) reported that application of 2% DAP + 100 ppm salicylic acid +0.05% sodium molybdate increased the grain yield. Foliar application of potassium nitrate @ 0.4% significantly increased the grain yield by 18.4% (Vekaria *et al.,* 2013). Blackgram height was significantly increased (37.28) by foliar application of urea and Methylotrophs extorquees PPFMs-Vm-11, which was superior to uninoculated control (30.28 cm plant^{-1}) (Madhaiyan, 2003). Keeping the above points in view, the present study was conducted to determine a suitable sowing time and foliar nutrition for higher mungbean production under rainfed vertisols of southern agro climatic conditions of Tamil Nadu.

MATERIAL AND METHODS

A field experiment was conducted during *Rabi* season (October to January) of 2011-12 (1st year), 2012-13 (2nd year) and 2013-14 (3rd year) at the Agricultural Research Station, Tamil Nadu Agricultural University, Kovilpatti. Experiment was laid out in split plot design replicated thrice with dates of sowing in main plots and soluble foliar fertilization in sub plots. The plot size was 5 x 4 m. The soil was clay in texture with sub angular blocky in structure with WHC of 65%, EC: 0.32 dSm^{-1}, pH: 8.45, available N: 140 kg/ha, available P: 15.5 kg/ha, available K: 340 kg/ha. Seven foliar fertilization including (F_1 – foliar spray of DAP 2%, F_2 – foliar spray of All 19 1%, F_3 – foliar spray of KNO_3 1%, F_4 – foliar spray of TNAU pulses wonder 2%, F_5 - seed treatment with *Rhizobium* and phosphorus solubilizing bacteria (PSB) (each 600 gram /ha), F_6 - seed treatment with *Rhizobium* and PSB (each 600 gram /ha)+ 2 % KCL + 100 ppm boric acid foliar spray, F_7 - seed treatment with *Rhizobium*, PSB and *Methylobaterium* (each 600 gram /ha) and foliar application of *Methylobaterium* - 2 ml / lit) were used in the study and sowing was done as per treatment (D_1: 39th standard week - 24 to 30 'Sep (pre-monsoon sowing), D_2 : 41st standard week - 8 to 14 'Oct (monsoon sowing), D_3: 43rd standard week - 22 to 28' Oct (post-monsoon sowing), respectively. All treatment received common fertilizer dose of NPKS @ 12.5: 25: 12.5: 10 kg/ha. Foliar spray was done at 30 and 45 DAS. Meteorological data regarding rainfall, temperature, relative humidity and sunshine hours were collected from meteorological observatory located near crop field at Agricultural Research Station, Kovilpatti and presented in Table 1.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Growth parameters:

Sowing dates had a great influence on growth

Table 1: Observed and derived weather parameter during the cropping period

Treatments	Max T (°C)	MinT (°C)	SS hrs/d	RH (%)	WV (km/ hr)	Evap (mm/day)	GDD	HTU	PTU	RTD (%)	RF (mm)	AGDD	AHTU
2011-12													
D_1	32.2	18.3	5.3	80.3	3.1	3.8	15.2	85.2	177.2	42.5	540.6	1280.5	7755.6
D_2	32.1	17.4	5.8	75.9	3.1	3.7	14.8	87.2	170.8	45.5	472.4	1135.8	6245.7
D_3	30.5	17.4	4.6	79.7	2.6	3.0	13.9	65.7	160.5	42.4	390.6	1030.7	5597.5
2012-13													
D_1	32.7	21.2	4.6	63.7	3.7	3.3	16.9	80.3	196.4	34.8	226.9	1324.1	6815.8
D_2	32.7	21.2	4.6	63.7	3.7	3.3	16.9	80.3	196.4	34.8	226.9	1324.1	6815.8
D_3	32.5	20.8	5.5	62.1	3.7	3.5	16.6	92.8	192.8	35.7	126.2	1277.2	6984.5
2013-14													
D_1	33.5	21.9	5.3	84.3	4.4	5.1	17.7	95.4	208.7	34.2	252.8	1486.9	8569.5
D_2	33.4	22.0	5.2	83.5	4.9	5.1	17.7	94.4	208.9	33.8	229.8	1447.9	8260.4
D_3	33.0	22.6	5.9	85.2	4.5	4.8	17.8	107.0	210.2	31.5	119.2	1313.8	7505.3

attributes like plant height, leaf area index (LAI) and dry matter production (DMP). Maximum plant height, LAI and DMP were recorded when the crop was sown as pre-monsoon sowing followed by monsoon sowing and further decrease was noticed in later sowing date (Table 1). Patange *et al*. (2012) reported that early sowing date recorded more dry matter accumulation, pod and seed yield (kg/ha) than delayed sowing. The plants from the delayed sowing were exposed to cool climate which has adversely affected the final growth of the plant (Barman *et al.*, 2013). Growth attributes also varied among different foliar fertilization. Maximum plant height, LAI and DMP were recorded in *Methylobacterium* treated plot. Madhaiyan (2003) reported that inoculation of *Methylobacterium* and methanol spray significantly increases the plant height and DMP of cotton than uninoculated control.

Yield parameters:

Pods/plant, no.of seeds/pod and seed weight/pods are an important yield component contributes significantly towards grain yield which was significantly affected by time of sowing and foliar fertilization. Results revealed that earlier sowing produced maximum number of pods per plant, pod length, number of seeds per plant and seed weight followed by monsoon sown and lowest were recorded in post monsoon sown crop. This result is in line the findings of Mili *et al*. (2012) and Sandhya Rani *et al*.(2014). Delayed sowing decreased the number of pods/ plant, grain/pod, and weight of grains/pod (Mukherjee *et al*., 2013). Continuously cloudy weather or rainfall, especially during the grain-filling stage, induces a significant loss in yield and results in poor grain quality (LIU Qi-hua *et al*., 2014). Differences in pod growth were also observed among foliar fertilization; the maximum number of pods/ plant, pod length and number of seeds/pod were observed in *Methylobacterium* inoculated plot followed by 2% KCl+ 100 ppm boric acid sprayed plot. Madhaiyan (2003) observed that application of PPFMs as foliar spray significantly increase the boll number, boll weight and kapas yield of cotton.

Yield :

Maximum grain yield was recorded by pre- monsoon

Table 2 : Effect of treatment on growth and yield attributes of greengram

Treat-ments	Pl ht (cm)			DMP (kg/ha)			LAI			No. of pods/pl			Pod length (cm)			No. of seeds/ pod			100 seed wt (g)		
	1st year	2nd year	3rd year	1st year	2nd year	3rd year	1st year	2nd year	3rd year	1st year	2nd year	3rd year	1st year	2nd year	3rd year	1st year	2nd year	3rd year	1st year	2nd year	3rd year
D_1	78.5	41.4	62.0	4541	3610	4589	3.52	2.85	3.18	36.7	13.3	50.3	8.1	7.1	7.9	11.2	9.8	8.4	3.17	3.14	3.20
D_2	68.2	41.5	61.0	4293	3635	4554	3.18	2.86	3.14	32.8	13.3	50.1	7.6	7.2	7.8	10.7	9.8	8.3	3.23	3.15	3.13
D_3	66.2	33.2	49.1	3918	3161	3837	2.85	2.26	2.44	31.9	11.1	38.8	7.2	6.1	6.9	9.7	8.6	6.2	3.14	3.07	3.01
S.E.±	2.8	1.9	2.0	164	181	159	0.12	0.13	0.10	1.37	0.6	1.6	0.3	0.4	0.3	0.4	0.4	0.3	0.13	0.17	0.13
C.D. (P=0.05)	7.8	3.8	5.6	455	36	441	0.34	0.27	0.28	3.80	1.3	4.4	NS	0.7	0.8	1.14	0.8	0.7	NS	NS	NS
F_1	69.0	41.4	53.4	4110	3650	3853	2.88	3.08	2.37	32.4	13.4	40.4	7.2	7.2	6.9	10.0	9.8	6.6	3.03	3.15	2.94
F_2	70.1	38.3	56.3	4168	3355	4202	2.80	2.67	2.73	33.4	11.9	45.1	7.5	6.5	7.4	10.3	9.2	7.4	3.17	3.10	3.06
F_3	66.5	34.1	58.9	3959	3250	4465	2.84	1.95	3.12	29.1	11.6	48.3	7.2	6.3	7.7	9.6	8.4	7.8	3.17	3.07	3.15
F_4	71.2	36.0	55.5	4322	3330	4142	3.40	2.30	2.76	35.1	11.9	43.8	7.8	6.6	7.3	10.8	9.0	7.2	3.21	3.08	3.07
F_5	69.4	38.3	57.6	4180	3400	4302	2.96	2.55	2.86	35.0	12.2	46.5	7.6	6.8	7.5	10.5	9.5	7.8	3.21	3.13	3.13
F_6	74.4	40.1	60.9	4448	3545	4660	3.62	2.85	3.27	35.4	13.1	50.3	8.0	7.0	7.9	11.1	9.7	8.2	3.22	3.14	3.21
F_7	76.2	42.7	61.1	4566	3740	4663	3.79	3.19	3.29	36.6	13.7	50.4	8.1	7.3	7.9	11.3	10.0	8.3	3.27	3.16	3.22
S.E.±	2.6	2.0	2.2	158	184	165	0.13	0.14	0.11	1.3	0.6	1.8	0.3	0.3	0.3	0.4	0.4	0.3	0.12	0.16	0.12
C.D. (P=0.05)	5.3	4.2	4.5	321	370	335	0.26	0.29	0.23	2.6	1.2	3.7	0.6	0.7	0.6	0.8	0.8	0.6	NS	NS	NS
M at S S.E.±	5.1	3.8	4.1	302	271	309	0.24	0.26	0.21	2.4	1.1	3.3	0.5	0.4	0.5	0.7	0.7	0.6	0.23	0.24	0.22
C.D.	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S at M S.E.±	4.6	3.5	3.8	274	250	286	0.22	0.24	0.20	2.2	1.1	3.1	0.5	0.4	0.5	0.7	0.7	0.5	0.20	0.23	0.20
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS= Non-significant

sown crop (39th standard week) followed by monsoon sown crop and minimum yield was recorded by post monsoon sown crop. Data indicated that, average yield reduction was about 6.1 kg day^{-1} from when the crop sowing was delayed from 26th September (D_1) to 22nd October (D_3). Pre monsoon (D_1) and monsoon (D_2) sown crop produced 41 and 37 per cent higher grain yield as compared to D_3 (Table 3). Rainfall received was distributed evenly for pre monsoon sown crop which favored for high yield compared to other treatments. With the delay in sowing, the amount of rainfall received from sowing to harvest decreased gradually which affects the growth, development and finally yield of the crop (Nasir Mahmood *et al*., 2013).

Differences in yield was also observed among foliar fertilization: maximum grain yield was registered by foliar application of *Methylobaterium* (2 ml / lit) on 30 and 45 DAS + seed treatment with *Rhizobium*, PSB and *Methylobaterium* (each 600 gram /ha) and which was followed by seed treatment with *Rhizobium* and PSB (each 600 g /ha) + 2% KCL + 100 ppm boric acid foliar spray. *Methylobacterium* species provided plants with cytokinins and auxin which in turn enhanced plant development and ultimately increased the yield (Lidstorm, and Chistoserdova, 2002). Cytokinin helps in promotion of cell division, delaying of senescence, counteracting apical bud dominance, translocation of assimilates and there by improve the yield potential of plants (Madhaiyan *et al*., 2005). Minimum grain yield was recorded in post monsoon sowing with foliar spray of KNO_3 1% at 30 and 45 DAS.

Meteorological data suggest that pre monsoon sown crop (24th Sep-30th Sep) was well benefited from monsoon rains. The crop attained vigorous vegetative growth prior to onset of flowering that was later used in pod formation and grain filling (Table 1). However, crop sown in post monsoon (D_3) suffered from dry spells due to decline in monsoon rain, GGD, HTU and low RH; growth was adversely affected. Even though during the year 2012 the crop received higher sunshine hours and higher AHTU in post-monsoon period, the crop failed to produce higher yield because of very low rainfall which fail to meet ET demand of crop. Based on the observation it is concluded that pre monsoon sowing with foliar spraying of *Methylobacterium* performed better to get maximum yield under rainfed vertisol of southern districts of Tamil Nadu.

Table 3: Effect of foliar fertilization and times of sowing on yield of greengram

Treatments	Yield (kg/ha)			
	1st year	2nd year	3rd year	Pooled mean
D_1	775	263	874	637
D_2	736	269	856	620
D_3	668	161	530	453
S.E.±	28	11	22	19
C.D. (P=0.05)	79	23	61	52
F_1	627	268	660	518
F_2	709	198	730	546
F_3	593	148	783	508
F_4	775	213	703	552
F_5	740	241	747	588
F_6	808	258	823	630
F_7	833	293	827	651
S.E.±	27	11	31	23
C.D. (P=0.05)	56	21	62	46
M at S SEd	52	19	54	41
C.D. (P=0.05)	NS	NS	NS	NS
S at M SEd	47	18	53	39
C.D. (P=0.05)	NS	NS	NS	NS

NS= Non-significant

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