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Short communication

Weed dynamics, yield and economics of pigeonpea influenced by growth promoters and mulching

S. Jawahar Chinnathurai, A. Veeramani* and P. Prema

Department of Agronomy, Agricultural College and Research Institute, Madurai, Tamil Nadu 625 104

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Pigeonpea or red gram having the total duration of 100-105 days and very slow in growth habit up to 50 to 65 DAS, facilitates the weeds to grow luxuriantly leads to even more than 75% yield loss and also complete crop failure under uncontrolled condition (Channappa goudar and Biradar, 2007). Conventionally, weeds are controlled by many means like chemical, manual, mechanical and biological. Chemical measures have ill effects to soil, succeeding crops and soil micro organisms. In this context, the idea of suppressing weed growth by plant growth would be highly possible. Similarly, unlike the other pulse crops, which act as cover crops namely blackgram and greengram, the red gram is slow growing during its early growing period up to 50-65 days apart from its erect stature, which induces the weed growth resulting in poor growth and development of crop and finally yield. Mulching is one of the possible ways to control weeds without using herbicides. Mulching reduced the population and dry weight of broad-leaved weeds significantly as compared to grass weeds (Radwan and Hussin 2001). Mulching has suppressing effect on weeds ands also conserves moisture (Tiwari *et al.* 1991).

Like mulching, applying growth promoters one way or other controls the weeds without herbicides by its indirect effect as it helps in rapid crop canopy coverage which in turn control weeds by shade effect. Hence, foliar spray of growth promoters was also included in addition to mulching to study their effect on weeds, yield and yield attributes and economics in red-gram.

A field experiment was conducted at Agricultural College and Research Institute, Madurai, Tamil Nadu during *Rabi* 2009-2010 to study the combined effect of foliar spray of growth promoters and mulching on weeds and their influence on yield and yield attributes and economics of red gram cv. *'APK1'*. The soil of the experimental field was well drained clay loam with organic carbon content of 0.46 per cent and low, medium and high N, P_2O_5 and K_2O respectively. The experiment consisted of two main plot treatments, *viz*. M_1- Organic mulch with blackgram residue 6 t/ha and M_2–no mulch. The foliar spray of growth promoters and micro nutrient mixture were assigned to sub plot, they were S_1 -foliar spray of micro nutrient mixture, S_2 – NAA 40 ppm, S_3 - salicylic acid 100 ppm, S_4 –Brassinolide 0.1 ppm, S_5 –triacontanol 500 ppm and S_6 -no spray.

Organic mulch namely black gram residues were cut into small pieces and applied at the rate of six t/ha on 15 days after germination in between the crop rows after thinning. The foliar spray of all the nutrients and growth promoters were done on 15, 30, 45 and 60 DAS. Micro nutrient mixture contains various nutrients at different concentration ($FeSO_4$ -0.5%**,** $MgSO_4$ -0.5% and $ZnSO_4$ -0.5%).

Weed density of predominant individual weeds of grasses, sedges and broad leaved weeds in each plot was recorded by using quadrate (0.5 x 0.5 m) in four places at random on 40 and 60 DAS of the crop and expressed as no/m^2. Observations on yield attributes such as number of flowers per plant, number of pods per plant, pod length, number of grains per pod and 100 grain weight and yield were recorded. All the data were statistically analyzed in split plot design and discussed in the results. In addition, economics covering cost of cultivation, gross return, net return and B:C ratio of the above experiment were worked.

The main plot treatment of mulching significantly reduced the density of grasses, sedges and broad leaved weeds (BLW) to 12.83, 14.54 and 16.30 no./m^2 at 40 DAS and 15.27, 17.03 and 17.64 no./m^2 at 60 DAS, respectively (Table 1 and 2). It might be attributed to hindrance of crop residue on the resources like light and aeration which are more essential for germination of weed seeds besides killing of weed seeds by increased soil temperature caused by high concentration of CO_2 under mulching than no mulching. Ahmed *et al.* (2007) reported that wheat straw mulch spreading had significant effect on weed suppression in wheat. The density of weeds was found to be more under no mulch irrespective of morphology charac-

***Corresponding author:** veeramanitnau@gmail.com

teristics of weeds following availability of all the resources in no mulch at 40 and 60 DAS (Table 1 and 2). Tamana Bakhtl *et al*. (2009) also reported maximum weed density of 40.33/m^2 in the weedy check, while the minimum weed density was recorded with mulching with news papers in pea.

Under sub plot treatments, foliar spray of NAA at 40 PPM registered lesser weed density of grasses, sedges and BLW (23.51, 24.35 and 27.00 no./m^2 at 40 DAS and 25.89, 27.38 and 27.89 no/m^2 at 60 DAS, respectively over rest of the treatments (Table 1 and 2). Rapid canopy coverage of plants which have been given with foliar spray of growth promoter NAA at 40 PPM could have suppressed the weed growth through shade effect during the critical crop weed competition period particularly at early stage of crop growth. NAA at 40 ppm gave much impact in influencing the growth of red gram. Kadam *et al.* (2008) reported that NAA at 30 ppm concentrate was found to be more effective in increasing the number of branches, total dry weight and chlorophyll content in black gram. The foliar spray of micronutrient mixture was found to be the next best treatment in reducing the weed density at 40 and 60 DAS in redgram (Table 1 and 2). The enhanced growth of plant next to NAA could have suppressed the weed density by providing shade effect. Gupta and Vyas (1994) observed that dry weight of soybean plant was increased due to application of zinc, iron and molybdenum.

Among the sub plot treatments, the plants in no spray treatment had no significance in checking the weed density owing to lesser crop canopy in this treatment wherein the density of grasses, sedges and BLW were 37.0, 40.8 and 45.4 no/m^2 at 40 DAS and 39.8, 43.8 and 46.7 no./m^2 at 60 DAS, respectively (Table 1and 2). This in corroboration with Talnikar *et al*. (2008) who reported heavy infestation of weeds in pigeon pea due to slow early growth of crop.

The interaction effect among mulching and foliar spray of growth promoters and micro nutrient mixture was significant on density of sedges at 40 DAS and grasses and sedges at 60 DAS (Table 1 and 2). Mulching in association with NAA at 40 PPM resulted in grater reduction of sedge weed density to 9.03 and 12.87 no./m^2 at 40 and 60 DAS, respectively and grasses to 11.1 no./m^2 at 60 DAS (Table 1 and 2). The less number of emergence of sedges and grasses than BLW in the experimental plot could have

Table 1. Effect of mulching and foliar spray of growth promoters on density of grasses, sedges and BLW weeds (no./m^2) in pigeonpea at 40 DAS

Foliar spray (S)	Grasses			Sedges			BLW		
	M_1- mulch	M_2-no mulch	Mean	M_1- mulch	M_2-no mulch	Mean	M_1- mulch	M_2- no mulch	Mean
S_1-Micro nutrient mixture	1.14 (11.90)	1.65 (42.98)	1.40 (27.44)	1.18 (12.98)	1.67 (44.56)	1.42 (28.77)	1.21 (14.34)	1.69 (47.36)	1.45 (30.85)
S_2-NAA 40 ppm	1.08 (10.03)	1.59 (36.98)	1.34 (23.51)	1.04 (9.03)	1.62 (39.67)	1.33 (24.35)	1.15 (12.13)	1.64 (41.86)	1.40 (27.00)
S_3-Salicylic acid 100 ppm	1.20 (14.02)	1.68 (46.12)	1.44 (30.07)	1.26 (16.23)	1.70 (48.23)	1.48 (32.23)	1.26 (16.32)	1.72 (50.57)	1.49 (33.45)
S_4-Brassinolide 0.1 ppm	1.11 (11.01)	1.64 (41.98)	1.38 (26.50)	1.16 (12.45)	1.672 (45.01)	1.42 (28.73)	1.23 (15.04)	1.70 (48.23)	1.47 (31.64)
S_5-Tricontanol 500 ppm	1.15 (12.10)	1.69 (47.12)	1.42 (29.61)	1.25 (15.89)	1.72 (49.90)	1.48 (32.90)	1.26 (16.34)	1.74 (53.12)	1.50 (34.73)
S_6-No spray	1.30 (17.89)	1.76 (56.12)	1.53 (37.01)	1.36 (20.67)	1.80 (61.01)	1.58 (40.84)	1.41 (23.65)	1.84 (67.14)	1.62 (45.40)
Mean	1.17 (12.83)	1.67 (45.22)		1.21 (14.54)	1.70 (48.06)		1.26 (16.30)	1.72 (51.38)	
	SEd±	LSD (P= 0.05)		SEd±	LSD (P= 0.05)		SEd±	LSD (P= 0.05)	
M	0.01	0.04		0.01	0.05		0.01	0.04	
S	0.01	0.03		0.01	0.03		0.01	0.03	
MxS	0.02	NS		0.02	0.06		0.02	NS	
S×M	0.02	NS		0.02	0.04		0.02	NS	

Data in parentheses are original values. Others are log (x+2) transformed values

Table 2. Effect of mulching and foliar spray of growth promoters on density of weeds BLW weeds (no./m²) in pigeonpea at 60 DAS

Foliar spray	Grasses			Sedges			BLW		
	M_1- mulch	M_2- no mulch	Mean	M_1- mulch	M_2- no mulch	Mean	M_1- mulch	M_2- no mulch	Mean
S_1-Micronutrient mixture	1.20 (13.87)	1.68 (45.97)	1.44 (29.92)	1.22 (14.78)	1.80 (47.89)	1.46 (31.34)	1.25 (15.67)	1.71 (48.78)	1.48 (32.23)
S_2-NAA 40 ppm	1.12 (11.13)	1.63 (40.65)	1.37 (25.89)	1.17 (12.87)	1.64 (41.89)	1.41 (27.38)	1.18 (13.02)	1.65 (42.76)	1.41 (27.89)
S_3-Salicylic acid 100 ppm	1.25 (15.89)	1.70 (48.45)	1.48 (32.17)	1.32 (18.98)	1.72 (50.87)	1.52 (34.93)	1.30 (17.89)	1.73 (51.78)	1.51 (34.84)
S_4-Brassinolide 0.1 ppm	1.20 (13.98)	1.69 (46.98)	1.45 (30.48)	1.23 (15.01)	1.70 (48.34)	1.47 (31.68)	1.26 (16.01)	1.71 (49.01)	1.48 (32.51)
S_5-Tricontanol 500 ppm	1.25 (15.98)	1.72 (49.98)	1.49 (32.98)	1.27 (16.78)	1.75 (53.98)	1.75 (35.38)	1.32 (18.67)	1.76 (54.98)	1.55 (36.83)
S_6-No spray	1.36 (20.78)	1.78 (58.87)	1.57 (39.83)	1.41 (23.78)	1.82 (63.89)	1.62 (43.84)	1.42 (24.56)	1.85 (68.90)	1.64 (46.73)
Mean	1.23 (15.27)	1.70 (48.48)		1.27 (17.03)	1.72 (51.14)		1.29 (17.64)	1.73 (52.70)	
	SEd±	LSD (P= 0.05)		SEd±	LSD (P= 0.05)		SEd±	LSD (P= 0.05)	
M	0.01	0.04		0.01	0.05		0.01	0.04	
S	0.01	0.03		0.01	0.03		0.01	0.03	
MxS	0.02	0.05		0.02	0.06		0.02	NS	
SxM	0.02	0.04		0.02	0.04		0.02	NS	

Data in parentheses are original values. Others are log (x+2) transformed values

paved the way to suppress those weeds easily under mulching when it combined with shade effect of plants given by NAA at 40 ppm.

The next best combination to check the sedges density (12.45 no./m²) at 40 DAS was mulching with foliar spray of brassinolide 0.1 ppm (Table 1 and 2). Whereas, at 60 DAS mulching combined with foliar spray of micronutrient mixture ranked second in bringing down the grasses (13.87 no./m²) and sedges (14.78 no./m²) density, which in turn comparable with the treatment (Table 1 and 2). The weed density of grasses and sedges was found to be more in the treatment combination of no mulch with no spray irrespective of stages.

Organic mulching recorded higher values of yield attributing characters like number of flowers/plant (41.36%), number of pods/plant (34.13%), test weight (15.45%) number of seeds/pod and seed yield (47.83%) over the control plot with no mulch (Table 3 and 4).

The improvement in the yield attributes under organic mulching might be due to maintenance of higher soil moisture in root zone which resulted in better nutrient uptake, increased growth, LAI and DMA, photosynthesis *etc*. resulting in higher yield attributes.

Organic mulching resulted in a substantial increase in redgram pod yield (1329 kg/ha) which accounts for 47.83% increase over no mulching. This was mainly due to optimum soil moisture content maintained in all stages of crop growth, which enabled higher nutrient uptake, greater dry matter accumulation, higher number of pods/plant, more grains/pod and increased hundred seed weight. Better control of weeds under mulch which could have also favored to increase the yield. Abubakkar *et al.* (2004) also made similar observations in summer green gram.

Among the foliar spray, NAA at 40 ppm influenced the yield attributes, *viz.* number of flowers/plant (50.06%), number of pods/plant (105%), pod length (19.46%) grains/pod and yield (40.11%) over the no spray control (Table 3 and 4).

In the present study also application of NAA was found to stimulate early flowering. The number of pods/plant was increased by the foliar application of NAA at 40 ppm. Similar results were reported by Subramani and Solamalai (2000) in legumes.

Table 3. Effect of mulching and foliar spray of growth promoters on no. yield attributes and grain yield of pigeonpea

Foliar spray	No. of flowers/plant			No of pod/plant			Grain yield (kg/ha)		
	M_1- Mulch	M_2- no mulch	Mean	M_1- Mulch	M_2- no mulch	Mean	M_1- Mulch	M_2- No mulch	Mean
S_1-Micronutrient mixture	184.7	138.9	161.8	215.3	156.9	186.1	1336	985	1160
S_2-NAA 40 ppm	205.7	152.5	179.1	252.3	175.3	213.8	1453	1069	1261
S_3-Salicylic acid 100 ppm	172.0	129.4	150.7	198.5	147.9	173.2	1319	912	1116
S_4-Brassinolide 0.1 ppm	186.3	137.0	161.7	210.4	152.1	181.2	1322	965	1144
S_5-Tricontanol 500 ppm	169.4	125.3	147.4	188.7	146.9	167.8	1302	903	1103
S_6-No spray	158.9	78.8	118.9	110.4	97.3	103.9	1240	560	900
Mean	179.5	127.0		195.9	146.1		1329	899	1114
	Sed±	LSD (P=0.05)		SEd±	LSd (P= 0.05)		SEd±	LSD (P= 0.05)	
M	3.9	16.9		4.6	19.6		29.1	125.3	
S	5.5	11.5		6.4	13.3		38.1	79.5	
MxS	8.1	21.2		9.4	24.5		57.2	152.2	
SxM	7.8	16.3		9.0	18.8		53.9	112.5	

Table 4. Effect of mulching and foliar spray of growth promoters on pod length yield attributes of pigeonpea

Treatment	Pod length (cm)	No. of seeds/ pod	100 grain weight (gram)
Mulching			
M_1-Mulch	5.68	5.21	9.49
M_2 –No mulch	4.70	4.10	8.22
LSD(P= 0.05)	0.57	0.51	0.89
Foliar spray			
S_1-Micronutrient mixture	5.33	4.72	8.87
S_2-NAA 40 ppm	5.40	5.09	9.71
S_3-Salicylic acid 100 ppm	5.27	4.61	8.72
S_4-Brassinolide 0.1 ppm	5.34	4.72	8.87
S_5-Tricontanol 500 ppm	5.29	4.66	8.87
S_6-No spray	4.52	4.14	8.07
LSD (P= 0.05)	0.38	0.34	0.62

The pod length was also increased by the application of NAA at 40 ppm (Table 4). The increased pod length may be attributed to increase in the number of cell as well as elongation of cells which is the characteristic action of auxin. Similar result was reported by Sharma (1999).

The gross return, net monetary returns and benefit cost ratio were higher under mulching with the combination of foliar application of NAA at 40 ppm. This combination registered ₹ 87,176/ha , ₹ 63969/ha and 2.76 as gross return, net profit and benefit cost ratio, respectively (Table 5). The

Table 5. Effect of mulching and foliar spray of growth promoters on economics of pigeonpea

Treatment	Cost of cultivation (x10^3 ₹/ha)	Gross returns (x10^3 ₹/ha)	Net returns (x10^3 ₹/ha)	B:C ratio
M_1S_1	25.46	81.06	55.59	2.18
M_1S_2	23.20	87.17	63.96	2.76
M_1S_3	23.14	79.14	55.99	2.42
M_1S_4	23.26	79.33	56.06	2.41
M_1S_5	23.18	78.12	54.93	2.37
M_1S_6	22.66	74.40	51.73	2.28
M_2S_1	24.06	59.10	35.03	1.46
M_2S_2	21.80	64.12	42.31	1.94
M_2S_3	21.74	54.72	32.97	1.52
M_2S_4	21.86	57.90	36.03	1.65
M_2S_5	21.78	54.18	32.39	1.49
M_2S_6	16.57	33.60	17.02	1.03

next best combination in registering the higher net profit (₹ 56068/ ha) and benefit cost ratio (2.41) was mulch with brassinolide 0.1 ppm which was followed by mulch with salicylic acid 100 ppm (Table 5). The treatment combination, no mulch with no spray registered lowest net return (₹ 17,022) and BC ratio (1.03) with lowest cost of cultivation.

SUMMARY

The experiment was laid out in split plot design and replicated thrice at Agricultural College and Research Institute, Madurai during *Rabi* 2009-2010. The main plot treatment consisted of mulching with crop residue and no mulch as control. Foliar spray of micronutrient mixture,

NAA at 40 ppm, salicylic acid at 100 ppm, brassinolide at 0.1 ppm, triacontanol at 500 ppm and no spray were assigned to sub plot. Among the main plot treatments, mulching with crop residue effectively controlled the weed density of grasses, sedges and broad leaved weeds which increased the yield attributes. The eonomic parameters, *viz*. gross return, net return, and benefit cost ratio were higher in mulching. The subplot treatment foliar spray of NAA at 40 ppm reduced the weed density significantly, which also enhanced the yield and yield attributes despite recording more economic returns. When both the main and subplot treatments combined together, they gave better control of sedges at 40 and 60 DAS and grasses at 60 DAS due to shade effect of robust stature of plants. This treatment combination resulted in substantial increase in yield and yield attributes and also more economic returns.

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