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Effect of sowing dates and weed control treatments on weed management and grain yield of greengram under rainfed condition

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ABSTRACT

The field experiment was conducted during 2014-16 in *Rabi* (winter) season (October - December) at Agricultural Research station, Kovilpatti, Tamil Nadu, India. The treatment combinations comprised of three dates of seeding, *viz*. last week of September, 2nd week of October and last week of October in main plot with four weed management treatments, *viz*. pendimethalin 0.75 kg/ha pre-emergence application (PE) *fb* hand weeding (HW) on 20 days after seeding (DAS), pendimethalin 0.75 kg/ ha PE *fb* quizalofop-ethyl 50 g/ha post-emergence application (PoE) on 20 DAS, pendimethalin 0.75 kg/ha PE *fb* imazethapyr 50 g/ha PoE on 20 DAS, imazethapyr 50 g/ha + quizalofop-ethyl 50 g/ha (tank mix) PoE at 20 DAS in the sub plot. The seeding during last week of September registered increased growth and yield parameters, *viz*. dry matter production (DMP), leaf area index (LAI), number of pods/ plants, pod length, number of seeds/pods which reflected on increased grain yield (850 kg/ha). Among the weed management treatments, pendimethalin 0.75 kg/ha PE *fb* HW on 20 DAS recorded significantly lower weed density and weed biomass which in turn produced increased growth and yield attributes and yield of the crop which was followed by application of pendimethalin 0.75 kg/ha PE *fb* quizalofop-ethyl 50 g/ha PoE on 20 DAS.

Greengram is one of the major pulse crops of our country and also it serves as an important protein source of our Indian diet. Greengram gives low seed yield mainly due to poor management and low soil fertility. In Tamil Nadu, blackgram (46%) and greengram (25%) are the major pulse crops accounting for about 71% of the area under pulses and the average yield level is far below the national average (650 kg/ha). The productivity of greengram during 2001-2016 ranged from 227 kg/ha to 788 kg/ ha and the mean value of productivity of greengram was 450 kg/ha (Vasanthakumar 2016). This indicates that there is a wide scope for increasing the productivity of greengram by proper management practice. Weed infestation is one of the major constraints in greengram cultivation. Competition with the weeds leads to 30 to 80% reduction in grain yield of greengram during summer and *Kharif* (rainy) seasons while 70-80% during *Rabi* (winter) season. (Algotar *et al*. 2015). The pendimethalin (pre-emergence) 1000 g/ha + one hand weeding (Singh *et al*. 2015); pendimethalin 30 EC + imazethapyr 2 EC) 1.00 kg/ha (Tamang *et al*. 2015), hand weeding at 20 and 30 DAS and hand hoeing at 20 and 30 DAS (Chaudhari *et al*. 2016) were found to be most effective in reducing density and biomass of weeds and producing maximum yield of greengram in different states of India. The relative efficiency of different herbicide when applied alone or in combination with other herbicides and management practices should be known to select location specific best weed control methods. Hence, the present study was under taken to study the effect of different weed management practices on weed control and grain yield of greengram under different weather conditions prevailing at different dates of seeding in Kovilpatti, Tamil Nadu.

The field experiment was conducted during 2014-16 in *Rabi* season (October - December) at Agricultural Research Station, Kovilpatti, Tamil Nadu, India. The experiment was conducted in split-plot design with three replications. The treatments comprised of three dates of sowing, *viz*. last week of September, 2nd week of October and last week of October as on 24.09.2015, 08.10.2015 and 22.10.2015, respectively in main plot with four different weed management practices, *viz*. pendimethalin at 0.75 kg/ha pre-emergence application (PE) *fb* hand weeding (HW) at 20 days after seeding (DAS), pendimethalin at 0.75 kg/ha PE

fb quizalofop-ethyl at 50 g/ha post-emergence application (PoE) on 20 DAS, pendimethalin at 0.75 kg/ha PE *fb* imazethapyr at 50 g/ha PoE on 20 DAS, imazethapyr at 50 g/ha + quizalofop-ethyl at 50 g/ha (tank mix) PoE on 20 DAS in the sub-plot. The soil is clay in texture with sub angular blocky in structure with WHC of 65%, EC: 0.32/dSm, pH: 8.45, available N: 140 kg/ha, available P: 15.5 kg/ha and available K: 340 kg/ha. Application of fertilizers 12.5: 25: 12.5 + 10 kg NPK+S/ha was done in the form of urea, DAP and MOP with the spacing of 30 × 10 cm. Irrigation was not given since the crop was grown as rainfed and sufficient rainfall occurred during the growing season. Data on plant height, leaf area index (LAI), dry matter production (DMP), number of pods/ plants, number of seeds/pods, test weight and seed yield were recorded replication wise and were statistically analysed. The weed flora at 20 DAS, weed density, relative weed density and biomass at 20 and 40 DAS were recorded. The meteorological data regarding rainfall, temperature, relative humidity and sunshine hours were collected from meteorological observatory located nearby experimental field at Agricultural Research Station, Kovilpatti. Derived parameters like Accumulated Growing Degree Day (AGDD) and Accumulated Helio Thermal Unit (AHTU) were worked out.

Rainfall, AGDD and AHTU Vs time of sowing

Among different sowing windows, the crop sown during the last week of September (24.09.2015) received higher amount of AGDD (1389) and AHTU (6452) and also higher amount of rainfall during the vegetative stage of the crop (**Table 1**). Sowing of greengram during 22.10.2015 (last week of October) received lesser amount of AGDD (1297) and AHTU (5570) and also less rainfall at vegetative (73.8 mm) and pod initiation (1.0 mm) stages and higher amount of rainfall (66.4 mm) during 50% flowering stage affected the crop very severely which was reflected by poor yield attributes and yield of greengram. This finding closely resembles to those reported by Miah *et al.* (2009) who opined that, the highest seed yield obtained from early sowing (2nd March) might be due to suitable temperature prevailing accompanied by higher soil moisture content due to sufficient rainfall in April, which enhanced the vegetative as well as reproductive growth of the crop. Meanwhile the lowest yield was recorded by late sown crop (April) due to excessive rainfall during pod filling stage in the month of June.

Weed flora, weed density and biomass

The broad-leaved weeds, *viz. Abutilon hirtum, Acalypha indica, Amaranthus viridis, Ageratum conyzoides, Corchorus olitorius, Celosia argentea, Digeria muricata, Euphorbia hirta, Phyllanthus maderaspatensis, Trianthema portulacastrum, Tridax procumbens* and sedge *Cyperus rotundus* and grassy weeds: *Cynodon dactylon, Rottboellia cochinchinensis* were observed in the experimental field and the relative density of different kinds of weeds is presented in **Table 3**.Variation in weed flora was noticed in different dates of sowing at 20 DAS. Broad-leaved weeds were higher in seeding prior to first monsoon rain (last week of September) (19 in number) whereas sedges were higher in greengram sown on last week of October (11.5). The grassy weeds remained same at different dates of sowing (**Table 2**). Among the different kinds of weeds observed in the experimental field, among the broad-leaved weeds *Digeria muricata,* and *Trianthema portulacastrum*; in sedges *Cyperus rotundus* and in grasses *Rottboellia cochinchinensis* recorded higher relative weed density nearly 25% each than other weed species (**Table 3**).

Among the weed management practices, application of pendimethalin 0.75 kg/ha PE *fb* HW on 20 DAS recorded significantly lower weed density (30.0 and 24.4 in number) and biomass (130.4 and 166.4 kg/ha) during 20 and 40 DAS, respectively which in turn influences increased growth and yield attributes and yield of the crop which was followed

Table 1. Rainfall, Accumulated Growing Degree Day (AGDD) and Accumulated Helio Thermal Unit (AHTU) received (mm) during different phenological stages of greengram

Phenological stages	Rainfall			AGDD			AHTU		
	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3
Germination	21.8	21.8	16.6	60	61	44	240	435	92
Vegetative	142.4	142.4	73.8	538	511	501	2792	2335	2675
50% flowering	35.6	35.6	66.4	125	129	124	844	868	80
50 % pod initiation	14.6	14.6	1.0	71	71	61	143	490	43
Pod development	79.6	79.6	39.8	503	470	445	1938	1330	1821
Physiological maturity	1.2	1.2	16.4	90	97	122	494	395	859
Total	295.2	295.2	214.0	1387	1339	1297	6452	5853	5570

D_1: Last week of September; D_2: Second week of October; D_3: Last week of October

by pendimethalin 0.75 kg/ha PE *fb* quizalofop-ethyl 50 g/ha PoE (**Table 2**). Similar observations were made earlier by Singh *et al*. (2015). Among total weed density at 20 and 40 DAS and weed biomass at 20 DAS did not differ significantly due to dates of sowing as also reported by Meena *et al*. (2017)

Growth and yield parameters

The sowing during last week of September registered significantly higher plant height (65.2 cm), DMP (4556 kg/ha), no. of pods/plant (26.1), no. of seeds/pod (7.9), 100 seed weight (3.6 g) which might be due to well distributed high rainfall, AGDD and AHTU (**Table 1**) than later dates of sowing that enhanced photosynthetic accumulates (**Table 4**). Gurjar *et al*. (2018) also reported the advantage of earlier sowing over late sowing. Greengram sown on later dates experienced high temperature during growth stages, heat and moisture stress at anthesis stage and shortening of grain filling duration which resulted in quick desiccation of leaves, unbalanced ratio of photosynthesis and respiration which ultimately resulted in low dry matter accumulation (Meena *et al*. 2017), decreased weight per grain and reduce grain weight (Poudel *et al*. 2020).

Among the weed management practices, application of PE pendimethalin 0.75 kg/ha *fb* HW on 20 DAS recorded significantly lower weed density and weed dry weight which in turn produced increased growth and yield attributes, *viz*. plant height (64.2 cm), DMP (4425 kg/ha), no. of pods/plant (26.1), No. of seeds/pod (7.8), 100 seed weight (3.6

Table 2. Effect of dates of sowing and weed management treatments on weed density and weed biomass on 20 and 40 DAS

Treatment	Weed density (no./m²)								Weed biomass (kg/ha)							
	20 DAS				40 DAS				20 DAS				40 DAS			
	BLW	Sedges	Grasses	Total weeds	BLW	Sedges	Grasses	Total weeds	BLW	Sedges	Grasses	Total weeds	BLW	Sedges	Grasses	Total weeds
Last week of September	4.3 (19.0)	2.5 (7.0)	3.0 (9.0)	5.9 (35.0)	5.6 (32.3)	2.9 (9.5)	2.1 (4.5)	6.8 (46.3)	5.7 (33.7)	4.6 (26.7)	8.5 (72.0)	11.5 (132.3)	14.0 (198.5)	5.2 (38.7)	5.9 (36.0)	16.5 (273.2)
Second week of October	4.0 (16.7)	2.5 (6.7)	2.6 (7.0)	5.5 (30.3)	5.1 (27.0)	2.3 (7.3)	1.8 (3.5)	6.0 (37.8)	7.3 (54.3)	4.2 (18.9)	8.7 (76.0)	12.2 (149.2)	13.0 (172.7)	4.2 (28.2)	5.2 (28.0)	14.9 (228.8)
Last week of October	3.9 (16.3)	3.3 (11.5)	2.8 (8.0)	6.0 (35.8)	4.7 (22.5)	2.8 (8.2)	2.0 (4.0)	5.9 (34.6)	7.1 (56.5)	7.7 (60.0)	8.2 (67.0)	13.5 (183.5)	11.4 (135.8)	4.1 (18.3)	5.6 (32.0)	13.5 (186.2)
LSD (p=0.05)	NS	0.4	NS	NS	NS	0.4	NS	NS	0.9	0.8	NS	NS	1.8	0.7	NS	2.1
Pendimethalin 0.75 kg/ha PE *fb* hand weeding on 20 DAS	3.6 (13.6)	2.7 (7.1)	3.0 (9.3)	5.5 (30.0)	3.8 (14.7)	2.2 (5.1)	2.1 (4.7)	4.9 (24.4)	5.6 (32.2)	4.7 (23.6)	8.6 (74.7)	11.4 (130.4)	10.6 (117.1)	3.4 (12.0)	6.0 (37.3)	12.8 (166.4)
Pendimethalin 0.75 kg/ha PE *fb* quizalofop-ethyl 50 g/ha PoE on 20 DAS	3.9 (15.3)	2.6 (8.0)	2.6 (6.7)	5.5 (30.0)	5.5 (30.4)	1.7 (4.7)	1.8 (3.3)	6.2 (38.4)	5.8 (35.6)	5.6 (37.3)	8.3 (69.3)	11.9 (142.2)	13.0 (172.0)	2.7 (12.2)	5.1 (26.7)	14.4 (210.9)
Pendimethalin 0.75 kg/ha PE *fb* imazethapyr 50 g/ha PoE on 20 DAS	3.6 (14.0)	2.6 (8.2)	2.9 (8.7)	5.5 (30.9)	5.4 (29.8)	3.0 (9.3)	2.1 (4.3)	6.6 (43.3)	6.9 (48.4)	4.9 (30.4)	8.3 (69.3)	12.1 (148.2)	13.2 (177.3)	4.0 (19.1)	5.9 (34.7)	15.1 (231.1)
Imazethapyr 50 g/ha + quizalofop-ethyl 50 g/ha (tank mix) PoE on 20 DAS	5.1 (26.4)	3.2 (10.2)	2.7 (7.3)	6.6 (44.0)	5.8 (34.2)	3.7 (14.2)	1.9 (3.7)	7.2 (52.1)	8.5 (76.4)	6.9 (49.4)	8.5 (73.3)	14.1 (199.2)	14.4 (209.6)	8.0 (70.2)	5.4 (29.3)	17.5 (309.1)
LSD (p=0.05)	0.3	0.1	0.2	0.5	0.4	0.2	0.2	0.5	0.6	0.5	NS	1.0	1.1	0.4	0.5	1.3
M at S LSD (p=0.05)	0.8	0.5	0.5	1.1	1.0	0.5	0.3	1.2	1.1	1.3	1.1	NS	2.4	1.0	1.0	2.8
S at MLSD (p=0.05)	0.6	0.4	0.4	0.8	0.8	0.4	0.3	0.9	1.0	0.9	NS	1.8	1.9	0.8	0.8	2.2

Note: Figures in the parentheses are original value PE- Pre-emergence; PoE- Post-emergence

Table 3. Effect of dates of sowing and weed management treatments on relative density of weeds on 20 and 40 DAS

Treatment	20 DAS											40 DAS												
	Dm	Eh	Av	Tpm	Co	Ai	Ca	Pm	Cr	Cd	Rc	Dm	Eh	Av	Tpm	Co	Ai	Tp	Ac	Ca	Pm	Ai	Cr	Cd	Rc
Last week of September	24	5	1	14	2	4	4	0	19	4	23	35	1	6	5	3	6	0	1	7	5	2	20	2	9
Second week of October	23	5	6	16	0	0	1	3	22	2	21	24	3	10	7	2	3	4	1	2	11	5	18	2	8
Last week of October	13	0	3	8	0	0	0	20	32	2	21	23	1	5	9	1	4	0	3	3	14	2	24	3	9
Pendimethalin 0.75 kg/ha PE *fb* hand weeding on 20 DAS	8	0	1	30	0	0	1	6	24	6	25	12	2	9	6	1	5	0	0	2	18	5	21	4	15
Pendimethalin 0.75 kg/ha PE *fb* quizalofop-ethyl 50 g/ha PoE on 20 DAS	23	9	8	7	0	0	0	7	25	4	18	30	5	10	10	1	4	2	3	4	9	2	12	1	8
Pendimethalin 0.75 kg/ha PE *fb* imazethapyr 50 g/ha PoE on 20 DAS	17	0	4	8	2	4	4	5	26	6	23	36	0	3	5	2	9	0	0	5	8	1	22	2	8
Imazethapyr 50 g/ha + quizalofop-ethyl 50 g/ha (tank mix) PoE on 20 DAS	32	4	0	7	0	1	3	14	23	2	15	31	0	6	7	3	0	4	3	4	4	3	28	1	6

Ah: *Abutilon hirtum*, Ai: *Acalypha indica*, Av: *Amaranthus viridis*, Ac: *Ageratum conyzoides*, Co: *Corchorus olitorius*, Ca: *Celosia argentea*, Dm: *Digeria muricata*, Eh: *Euphorbia hirta*, Pm: *Phyllanthus maderaspatensis*, Tpm: *Trianthema portulacastrum*, Tp: *Tridax procumbens*, Cr: *Cyperus rotundus*, Cd: *Cynodon dactylon*, Rc: *Rottboellia cochinchinensis*

Table 4. Effect of dates of sowing and weed management treatment on growth and yield attributes and yield of greengram

Treatment	Plant height (cm)	DMP (kg/ha)	No. of pods/ plant (no.)	No. of seeds/ pod (no.)	100 seed weight (g)	Seed yield (kg/ha)	Cost of cultivation (`/ha)	Net returns (`/ha)	B:C
Last week of September	65.2	4556	26.1	7.9	3.6	850	17116	29634	2.73
Second week of October	60.9	4119	24.3	7.1	3.5	733	17116	23171	2.35
Last week of October	54.4	3615	11.8	6.3	3.0	614	17116	16640	1.97
LSD (p=0.05)	7.9	533	3.0	0.9	0.4	95	-	-	-
Pendimethalin 0.75 kg/ha PE *fb* HW on 20 DAS	64.2	4425	26.1	7.8	3.6	808	17350	27108	2.56
Pendimethalin 0.75 kg/ha PE *fb* quizalofop-ethyl 50 g/ha PoE on 20 DAS	61.7	4207	24.2	7.2	3.4	757	17105	24512	2.43
Pendimethalin 0.75 kg/ha PE *fb* imazethapyr 50 g/ha PoE on 20 DAS	59.4	4035	23.5	7.0	3.4	730	17255	22895	2.33
Imazethapyr 50 g/ha + quizalofop-ethyl 50 g/ha (tank mix) PoE on 20 DAS	55.3	3720	20.0	6.2	3.1	633	16755	18078	2.08
LSD (p=0.05)	5.1	349	2.0	0.6	0.3	64	-	-	-

g). This is in line with the findings of Sudesh Kumar *et al.* (2019). This result was at par with application of PE pendimethalin 0.75 kg/ha fb PoE quizalofop-ethyl 50 g/ha on 20 DAS (**Table 4**).

Seed yield: The maximum seed yield (850 kg/ha) was recorded under sowing of greengram during last week of September over sowing of greengram on second and last week of October (733 and 614 kg/ha) (**Table 4**). Bobade *et al.* (2018) also reported that early sowing of greengram (June 23) recorded higher yield than late dates of sowing. Among the weed management practices, application of pendimethalin 0.75 kg/ha PE *fb* HW on 20 DAS recorded significantly increased seed yield of greengram (808 kg/ha) due to their effectiveness in weed control as observed by Singh *et al.* (2015) with pendimethalin 1000 g/ha PE +1 hand weeding

Economics

The monetary returns of *Rabi* (winter) greengram decreased with the delay in sowing date (**Table 4**). The maximum net return (₹ 33525/ha) and B:C (2.93) were recorded under sowing of greengram on last week of September with pendimethalin 0.75 kg/ha PE *fb* HW on 20 DAS. This was followed by PE pendimethalin 0.75 kg/ha PE *fb* quizalofop ethyl 50 g/ha PoE on 20 DAS.

It may be concluded that, seeding of greengram during last week of September with pendimethalin 0.75 kg/ha PE *fb* HW on 20 DAS results in better weed management and higher grain yield under rainfed vertisol condition.

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