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Weed Dynamics and Yield of Fieldpea (*Pisum sativum* L. var *arvense*) as Influenced by Planting Methods, Irrigation Schedule and Weed Management Practices

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ABSTRACT

An investigation was conducted during winter seasons of 2007-08 and 2008-09 on sandy loam soil at G.B. Pant University of Agriculture & Technology, Pantnagar to study the weed dynamics and seed yield of fieldpea under different planting methods, irrigation levels and weed management practices. Results revealed that density and dry matter of weeds/unit area, yield attributes as pods/plant, 1000-grain weight, grain yield/plant and grain yield of fieldpea were significantly higher under raised bed planting as compared to flat bed. Planting on raised bed increased grain yield of fieldpea by 17.5% over flat bed. Two irrigations applied at critical stages i.e. pre-flowering and pod formation proved promising in increasing the yield attributes and grain yield of pea. In weedy check, Cyperus rotundus and Cirsium arvense constituted 26.4, 29.5, 31.1% and 15.1, 19.5, 16.5% of total weed flora counted at 60, 90 and 120 days after sowing, respectively. One hand weeding done at 25 days after sowing (DAS) reduced the density and dry matter of weeds significantly and increased the values of yield attributes and grain yield as compared to pendimethalin 1.0 kg/ ha applied as pre-emergence and weedy check.

Key words: *Fieldpea, Planting method, Irrigation levels, Weed management*

INTRODUCTION

Field pea is one of the most important grain pulse crop of the world. Field peas are of two types based on the consumption: dry peas and green peas. Dry peas are used as split (dal) and besan for various preparation and green pods are used as vegetables. Crop management factors, such as optimum sowing time and method, plant population, weed competition, water and nutrients affect the yield of field pea. Among these, competition due to weeds is important as uncontrolled weed growth has been reported to cause yield reduction 77.2%[10]. Slow initial growth of field pea and wide spacing provide congenial environment for weeds to grow and compete with crop. Fieldpea is infested heavily with annual grasses, broad-leaved weeds and sedges. Weeds compete with crop plants for various production resources such as nutrients, moisture, sunlight and space and consequently reduce the yield.

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In spite of a lot of advantages, the productivity of fieldpea in the country is very low, which is mainly due to poor attention of growers, nonchalant attitude of government towards increasing fieldpea production, cultivation on marginal and starved lands with residual soil moisture and lack of site specific agro-techniques especially for crop establishment, irrigation schedule and adoption of suitable weed management practices[1].

Hence, the study is under taken to elucidate the effect of planting methods, irrigation schedule and weed management practices on weed dynamics, weed growth and yield attributes and yield of fieldpea crop.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* seasons of 2007-08 and 2008-09 at N. E. Bourlaug Crop Research Centre of G. B. Pant University of Agriculture and Technology, Pantnagar. The Pantnagar is situated at 29°N latitude, 79.3°E longitude and at an altitude of 243.84 metres above the mean sea level in the *tarai* belt of *Shivalik* range of Himalayan foot hills. The soil of experimental site was sandy loam in texture having medium organic carbon (0.57%), available nitrogen (286.9 kg/ha), phosphorus (16.1 kg/ha) and potassium (251.1 kg/ha) contents with neutral in reaction (pH 7.4). A total rainfall of 2.8 mm (no rainy day) during 2007-08 and 20 mm (3 rainy days) during 2008-09 was received at experimental site during crop period. The crop period (November to March) was characterized by 17.4 to 31.6 ^{o}C of mean monthly maximum temperature and 4.6 to 13.8 ^{o}C mean monthly minimum temperatures. Treatments consisted of two planting methods (raised bed and flat bed), two irrigation levels (no irrigation and irrigations at critical stages i.e. pre-flowering and pod formation) and three weed management practices (weedy, one hand weeding at 25 days after sowing (DAS) and pendimethalin 1.0 kg/ ha as pre-emergence) were tested in split plot design keeping combination of planting methods and irrigation levels in main plots and weed management in sub plots with four replications. Raised beds having width of 67.5 cm at bottom and 37.5 cm at top were prepared with the help of tractor drawn raised bed maker. Inverted trapezoidal shape furrows of 30 cm in between the raised bed were utilized for irrigation purpose. Two rows of fieldpea were accommodated on the raised beds while on flat bed a spacing of 30 cm between the rows was maintained. The crop cultivar of Pant P-13, was sown on 15 and 17 November during first and second year, respectively. A basal application of 18 kg N/ha and 46 kg P_2O_5/ ha was done uniformly through DAP (diammonium phosphate) in all experimental plots. Application of Pendimethalin 1.0 kg/ ha was made through Stomp 30% EC just after sowing and hand weeding treatment was executed at 25 DAS. Weed population was studied with the help of a quadrate (50cm×50cm) placed in second row in the different corners of the plot for different observations. The weeds falling within the quadrate were identified, counted species wise at 60, 90 and 120 days after sowing. The total number of weeds/ m^2 was calculated by multiplying the population with a constant 4. Other cultural practices were adopted as per recommendations for the crop. Observations on yield attributes and yield were recorded. The data recorded for each parameter were subjected to analysis for variance for Split plot design. Analysed data for each character were tabulated treatment wise and presented in results and discussion. Overall differences were tested for 'F' test at 5% level of significance.

RESULTS AND DISCUSSION

Weed Species

Weed flora of the experimental field were collected, identified and classified as sedges,

grassy and broad leaved weeds (Table 1). The predominant weeds in fieldpea crop were *Cyperus rotundus, Cirsium arvense, Polygonum convolvulus* and *Chenopodium album*. Rana *et al*.,[8] also observed the dominancy of above weed species in fieldpea but their intensity varied with place to place.

Species-wise weed population

Cyperus rotundus

The density of *Cyperus rotundus* increased with advancement of crop age and reached to the maximum at maturity i.e. 120 DAS in all the treatments (Table 2). Data revealed that *Cyperus rotundus* alone constituted 26.4, 29.5 and 31.1% of total weed flora in weedy check counted at 60, 90 and 120 DAS, respectively.

Raised bed planting recorded significantly higher density of *Cyperus rotundus* as compared to flat bed at all the stages of crop growth. The density of *Cyperus rotundus* was significantly higher under two irrigations applied at pre-flowering and pod formation stage as compared to no irrigation at all the stages of crop growth except at 60 DAS where the difference was non-significant. This might be due to adequate moisture availability, better root proliferation and nutrients supply to weeds. The heavy weed growth does not seem to be high enough to compensate the overall advantages accrued due to proliferated crop growth and development under irrigated condition. Chauhan *et al*.,[4] observed no significant effect of irrigation on the density and dry matter of weeds in fieldpea. The *Cyperus rotandus* density was significantly higher under weedy check than remaining treatments. Application of pendimethalin 1.0 kg/ha as pre-emergence recorded significantly higher *Cyperus rotandus* density than HW 25 DAS at all the stages of crop growth.

Cirsium arvense

In weedy check, *Cirsium arvense* alone constituted 15.1, 19.5 and 16.5% of total weed density in fieldpea at 60, 90 and 120 DAS, respectively (Table 2).

The density of *Cirsium arvense* was significantly higher in raised bed as compared to flat bed at all the stages of crop growth. The density of *Cirsium arvense* was significantly higher under two irrigations applied at critical stages as compared to no irrigation at 90 and 120 DAS stages of crop growth, however at 60 DAS stage the difference between irrigation levels was non-significant. One hand weeding done at 25 DAS recorded significantly lower density of *Cirsium arvense* than pendimethalin 1.0 kg/ha as PE and weed check at all the stages of crop growth.

Total weed density and dry matter accumulation of weeds:

Comparatively higher density and dry matter accumulation by weeds were observed in fieldpea by planting on raised bed as compared to flat bed at all the stages of crop growth, which might be due to reduced compaction, increased porosity and adequate moisture and nutrients supply (Table 2). Moreover, during preparation of raised bed the propagating material of weeds which were buried inside the soil came out on the upper surface where they germinated under the influence of proper moisture and increased the number and dry weight per unit area. These weed plants exploited sufficient resources available in furrows too and became robust in nature that increased dry matter content in them. Furthermore, the better performance of individual crop plant under raised bed planting seems to be high enough to overcome the adverse effect of higher weed competition. In contrast to above findings, Parminder *et al*.,[6] reported lower density and dry matter of weeds in raised bed planting.

The density and dry matter of weeds under irrigated condition were significantly higher as compared to no irrigation. This might be ascribed to adequate moisture availability, better root proliferation and nutrients supply to weeds. The heavy weed growth did not seem to be high enough to compensate the overall advantages accrued

due to proliferated crop growth and development under irrigated condition.

The density and dry matter of weeds was significantly higher in weedy check as compared to one hand weeding at 25 DAS and pendimethalin 1.0 kg/ha as PE at all the stages of crop growth. Significantly lower weed density and dry matter was recorded in one hand weeding at 25 DAS treatment than pendimethalin 1.0 kg/ha applied as pre-emergence (Table 2). At 25 DAS, the weeds emerged were removed totally while in chemical treated plots, the residual effect of pre-emergence application of pendimethalin 1.0 kg/ha decreased slowly with the passage of time, which allowed the weeds to emerge after 15-20 DAS. Hence, the crop-weed competition was seen more in case of pendimethalin 1.0 kg/ha as compared to one hand weeding at 25 DAS where crop suppressed the weed growth by smothering effect in later stages.

Yield and yield attributes

Number of seeds/pod and Number of pods/plant: The variations in number of grains per pod due to different treatments were statistically non-significant (Table 3). Raised bed planting of fieldpea significantly increased number of pods per plant by 27.5% over flat bed. Two irrigations applied at pre-flowering and pod formation stages proved promising in enhancing the number of pods per plant significantly as compared to no irrigation. The increase in number of pods per plant under irrigated treatment was 34.9% over no irrigation. Removal of weeds through hand weeding at 25 DAS recorded significantly more number of pods per plant as compared to pendimethalin 1.0 kg/ha and weedy check. At 25 DAS treatment produced 13.2 and 21.5 % more pods per plant over pendimethalin 1.0 kg/ha and weedy check, respectively (Table 3).

Grain yield/plant: Planting fieldpea on raised bed produced significantly higher grain yield per plant over flat bed. The increase in grain yield/plant was to the tune of 10.9 % (Table 3). Irrigations phased at critical stages out yielded no irrigation with a margin of 26.5 per cent[7]. Water application favoured the cell division, cell elongation and turgidity maintenance of plants, which in turns led to better plant growth, increased photosynthetically active area and assimilation of more photosynthates and ultimately the yield. Invariably increased availability of moisture and nutrients under irrigated condition led to increased growth and helped in further transfer of photosynthates to reproductive organ thereby tended to increase the yield. One hand weeding done at 25 DAS produced significantly higher grain yield per plant over remaining weed management treatments. The increase in yield under one hand weeding at 25 DAS was to the tune of 12.1 and 30.8 % over pendimethalin 1.0 kg/ha applied as pre-emergence and weedy check, respectively.

1000-grains weight: Fieldpea grown on raised bed produced significantly bolder seeds as compared to flat bed planting due to better utilization of resources, which increased soundness of grains. Two irrigations applied at critical stages yielded significantly higher 1000-grains weight as compared to no irrigation. The increase in 1000-grains weight under irrigated treatment was 2.83 % over no irrigation[2]. Significantly higher 1000-grains weight was obtained under one hand weeding at 25 DAS (219.2 g) than pendimethalin 1.0 kg a.i./ha applied as pre-emergence and weedy check. The minimum 1000-grains weight (210.56 g) was recorded under weedy condition.

Grain Yield per hectare: Fieldpea planted on raised bed out yielded flat bed during both the years. The raised bed planting increased mean grain yield per hectare by 17.5% over flat bed. This might be due to profuse branching, better root growth, adequate moisture absorption, increased nutrient uptake and increased dry matter accumulation per plant under raised bed planting[2].

Two irrigations applied at critical stages i.e. pre-flowering and pod formation yielded significantly higher than no irrigation. The irrigation of fieldpea at critical stages delayed the flowering and maturity significantly as compared to no irrigation treatment. This might be due to prolonged vegetative period as a result of adequate moisture availability under irrigated condition as compared to no irrigation where plants were forced to complete their life cycle early due to non-availability of adequate moisture needed for their metabolic activity[3].

During first year i.e. 2007-08, one hand weeding done at 25 DAS was the highest yielder (2606 kg/ha). Hand weeding at 25 DAS yielded 10.1 and 33.8 % more grains per hectare over pendimethalin 1.0 kg/ha applied as PE and weedy check, respectively during 2007-08. The minimum grain yield (1948 kg/ha) was recorded under weedy condition. A weed free environment at initial stages of crop growth till the critical period of crop-weed competition, facilitated good growth of crop by offering least competition for water, nutrients, light and space with weeds, which ultimately reflected on yield. Furthermore, the apprehension can be made that up to 45 DAS, weeds did not attain much growth and subsequently the crop canopy development was sufficient enough to smother the weeds, which emerged in the later stages of crop growth[9]. On contrary, During 2008-09, pendimethalin 1.0 kg/ha applied as PE recorded significantly higher yield over hand weeding at 25 DAS. This might be due to difference in rainfall received during crop period. In first year of cropping, only 2.8 mm rainfall was recorded while in 2008-09, a total of 20 mm rainfall was received after first week of sowing which might have variable response on the efficacy of herbicide. The efficacy of pendimethalin increases with increasing moisture content in the soil[5].

Table 1: Weed flora of the experimental field

Botanical name	Common name	Family
Sedges		
Cyperus rotundus L.	Purple nut sedge	Cyperaceae
Grassy weeds		
Phalaris minor L.	Little seed canary grass	Poaceae
Broad leaved weeds		
Cirsium arvense (L.) Scop	Canada thistle	Asteraceae
Chenopodium album L.	Lambsquarters	Chenopodiaceae
Coronopus didymus (L.) Sm	Swinecress	Brassicaceae
Fumaria parviflora L.	Fumitory	Fumariaceae
Melilotus indica (L.) All.	Yellow sweet clover	Fabaceae
Polygonum convolvulus L.	Wild buck wheat	Polygonaceae
Anagallis arvensis L.	Blue pimpernel	Primulaceae
Linaria vulgaris L.	Yellow toadflare	Scrophulariaceae
Solanum nigrum L.	Black nightshade	Solanaceae

Table 2: Density of major weeds as influenced by different treatments at various crop stages

Treatments	Weed density (Plants/ m^2)									Dry matter accumulation (DMA) of weed (g/m^2)		
	Cyperus rotundus			*Cirsium arvense*			Total Weeds					
	Crop duration			Crop duration			Crop duration			Crop duration		
	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS
Planting method												
Raised bed	7.25	12.42	20.42	3.92	8.04	9.83	21.92	36.67	64.62	59.1	73.6	103.2
Flat bed	5.54	9.96	14.62	3.17	7.04	8.71	16.08	29.67	45.00	48.7	66.6	78.0
S.Em.±	0.18	0.19	0.15	0.17	0.24	0.21	0.32	0.48	0.47	0.6	0.5	1.0
CD (P=0.05)	0.59	0.62	0.47	0.37	0.78	0.67	1.02	1.56	1.51	1.8	1.5	3.3
Irrigation level												
No irrigation	6.25	9.16	15.92	3.42	6.38	8.88	18.50	27.29	49.50	53.1	62.5	84.4
Irrigation at critical stages	6.54	13.20	19.12	3.67	8.71	9.67	19.50	39.04	60.12	54.7	77.7	98.8
S.Em.±	0.18	0.19	0.15	0.17	0.24	0.21	0.32	0.48	0.47	0.6	0.5	1.0
CD (P=0.05)	NS	0.62	0.47	NS	0.78	0.67	NS	1.56	1.51	NS	1.5	3.3
Weed management practice												
Weedy	8.62	14.94	22.62	4.94	9.88	12.00	32.69	50.56	72.62	81.6	107.2	142.9
Hand weeding at 25 DAS	3.87	8.50	12.31	1.94	5.38	6.50	7.56	19.94	35.50	31.8	42.6	50.0
Pendimethalin 1.0 kg/ha as PE	6.69	10.12	17.62	3.75	7.38	9.31	16.75	29.00	56.31	48.3	60.8	79.0
S.Em.±	0.21	0.23	0.36	0.17	0.25	0.32	0.33	0.56	0.70	0.5	0.6	1.3
CD (P=0.05)	0.61	0.66	1.04	0.50	0.73	0.94	0.97	1.63	2.04	1.5	1.7	3.7

Table 3: Effect of different treatments on yield attributes (Pooled data of two years) and grain yield

Treatment	Yield attributes				Grain yield (kg/ha)		
	Pods/ plant	Seeds/ pod	Grain weight/plant (g)	1000 grain weight (g)	2007-08	2008-09	Mean
Planting method							
Raised bed	19.40	4.15	13.02	218.00	2524	1861	2192
Flat bed	15.21	3.98	11.74	211.08	2089	1639	1864
S.Em.±	0.28	0.06	0.22	0.90	36	37	
CD (P=0.05)	0.91	NS	0.71	2.86	114	121	
Irrigation level							
No irrigation	14.73	4.00	10.93	211.54	2021	1569	1795
Irrigation at critical stages	19.87	4.14	13.83	217.54	2592	1917	2254
S.Em.±	0.28	0.06	0.22	0.90	36	37	
CD (P=0.05)	0.91	NS	0.71	2.86	114	121	
Weed management Practice							
Weedy	15.79	3.98	10.68	210.56	1948	1528	1738
Hand weeding at 25 DAS	19.18	4.17	13.98	219.19	2606	1750	2178
Pendimethalin 1.0 kg/ ha as PE	16.94	4.06	12.47	213.87	2367	1944	2155
S.Em.±	0.36	0.05	0.16	0.91	44	43	
CD (P=0.05)	1.06	NS	0.47	2.66	130	128	

CONCLUSION

The study revealed that raised bed planting is an advantageous technique for getting higher grain yield in field pea. Two irrigations applied at critical stages i.e. pre-flowering and pod formation was found optimum for exploiting the yield potential of fieldpea under *tarai* soil of Uttarakhand. Under un-irrigated conditions, one hand weeding at 25 days after sowing was more effective than pre-emergence application of pendimethalin 1.0 kg/ha. But when there is optimum moisture in soil or irrigated condition, it better to go for application of pendimethalin 1.0 kg/ha as pre-emergence.

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