Original Research Article

Yield and yield attributes of chickpea (*Cicer arietinum* L.) as influenced by planting dates and weed management systems.

ABSTRACT

Chickpea is one of the major winter legumes of Nepal, grown in terai and inner terai predominantly. To ascertain the degree of variation exhibited by the weed management practices at different stages of chickpea crop growth due to influence of dates of sowing, an experiment was conducted during *rabi* season of 2018-19 and 2019-20 at the farmer's field in Bhairahawa, Rupandehi district, Lumbini Province, Nepal. This location has a typical sub tropical climate characterized by hot, dry summer and cool winter. The field experiment consisted of two factors; *viz*. dates of sowing and weeds management practices and was conducted in split plot design with three replications. Three dates of sowing i.e. 10th November, 25th November and 5th December were allocated under main plot and eight weed management practices i.e. weedy, weed free (two hand weeding at 30 and 60 DAS), Pendimethalin (pre-emg.) @ 1 kg a.i. ha^{-1}, Quizalofop (POST) @ 50 g a.i. ha^{-1}, Imazethapyr (POST) @ 37.5 g a.i. ha^{-1}, Pendimethalin @ 1 kg a.i. ha^{-1} followed by Quizalofop @ 50 g a.i. ha^{-1}, Pendimethalin @ 1 kg a.i. ha^{-1} followed by Imazethapyr @ 37.5 g a.i. ha^{-1} and Pendimethalin @ 1 kg a.i. ha^{-1} followed by mechanical weeding. The maximum and the minimum yield attributes were found to be significantly different in the 10th November-sown crop and the 5th December-sown crop, respectively. In weed management practices, the net return obtained from weed free plot was higher than all other treatments. Among herbicides, Pendimethalin followed by Quizalofop recorded more values of yield attributes and yield which were the minimum in Imazethapyr treatment due to its phytotoxic effect on the crop, the Harvest index was recorded maximum under Pendimethalin (PRE) treated crop.

K**ey word:** Chickpea, Planting dates, Weed, Yield

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an important food legume and has exceptional, immediate potential for alleviating human malnutrition in tropical and sub-tropical countries by virtue of its nutritional and agronomic advantages. It contains on an average, 23% protein, 64% carbohydrates, 5% fat, 65% crude fibers, 3% ash and a high mineral content (Oberoi *et al*. 2010 and Shamsi 2010). With around 17.8 million ha farmed in 56 countries, it is the second most important pulse crop after common bean (*Phaseolus vulgaris* L.) (FAOSTAT, 2020). In Nepal, chickpea crop ranks second among legumes in the both terms of cropping coverage and productivity. The acreage of chickpea is approximately 9,653 ha, with the yield and productivity of 10,675 Mt and 1,106 kg/ha, respectively (MoALD, 2019). Chickpea is a rainfed crop growing in warm valleys and river basins in the highlands; however, in the long–duration rice–growing belts of Nepalese terai, late chickpea planting is a frequent practice (NGLRP, 2018). The early sowing results in excess vegetative growth and greater weed infestation leads to poor pod setting and yields. The planting of chickpea is usually delayed up to December. This late sown crop experiences very low temperature at initial stage resulting in poor vegetative growth and yields (Mohammadnejad *et al.* 2005; Shamsi, 2010).

Weeds are the major problem in irrigated chickpea. Seasonal weed competition in winter pulses has been reported to offer serious competition and causes yield reduction to the extent of 75% in chickpea (Chaudhary *et al*. 2005). According to Kakade *et al.* (2020), *Celosia argentea, Euphorbia geniculata, Tridex procumbance, Anagallis arvensis, Cyperus spp., Digitaria sanguinalis, Amaranthis viridis* and others are the key weeds of rabi-season-chickpea field. The high cost and unavailability of labour at right time, sometimes force the farmer for opting alternative, cheaper and easier method of chemical weed control. At present several herbicides viz. metribuzin, Pendimethalin, metolachlor, clodinafop, quizalafop and Imazethapyr are presently being used for controlling both grassy and broad-leaved weeds, but their effect under different agro-climatic conditions are not been well defined. Considering the above facts in view, it was realized to evaluate the performance of chickpea under different sowing dates and weed control methods under agro-climatic condition of Rupandehi district, Lumbini Province, Nepal.

MATERIALS AND METHODS

A field experiment was conducted during winter season 2018-19 and 2019-20 at a farmer's field which is geographically situated at 27.5065° N latitude and 83.4377° E longitude and at an altitude of 103 masl, Bhairahawa, Rupandehi district, Lumbini Province, Nepal. This location has a typical sub tropical climate characterized by hot, dry summer and cool winter. The soil of experimental site was sandy clay loam in texture with slightly saline in reaction (pH-7.2). It was low in organic C (0.33%) and available nitrogen (168.9 kg/ha), medium in available phosphorus (26.6 kg/ha) and potassium (242.5 kg/ha) in soil surface. The field was kept under rice - wheat rotation for the last eight years. Treatments consist of three sowing dates viz. 10th November, 25th November and 5th December and eight weed control systems viz. weedy, weed free, Pendimethalin 1 kg/ha pre-emergence, Quizalofop 50 g/ha post-emergence, Imazethapyr 37.5g/ha post-emergence, Pendimethalin followed by Quizalofop, Pendimethalin followed by Imazethapyr and Pendimethalin +mechanical in split plot design with three replications. The chickpea "T-59 (Uday)" was sown using seed rate of 80 kg/ha with spacing 30×10 cm. The crop was harvested by using sickles. The total rainfall received during the crop season was 22.1 mm. Crop was raised with recommended package of practices for the region. Herbicides were applied as per treatments with hand sprayer fitted with flat fan nozzle and the spray volume was 400 litters/ha. Density, dry weight and weed control efficiency of weeds were observed at 60 and at crop harvest. Data on weed density was recorded from an area enclosed in the quadrate of 0.25m^2 randomly

selected at four places in each plot. Weed species were separately counted from each sample and their density was recorded as average number/m^2. Weed control efficiency was calculated by WCE (%) = weed population in control plot - weed population in treated plot/ weed population in control plot x 100. Oven dry weight of weeds was recorded at 70^0C for 48 hr. and expressed as dry matter production/m^2. Weed data subjected to square root transformation ($\sqrt{x+0.5}$) before statistical analysis. Crop was harvested when pod being to turn yellow and leaf start shedding on 30th March, 2019 and 3rd April, 2020. Crop were sun dried biological yield were recorded separately for each treatment. Data collected on various parameters were analyzed statistically for valid conclusion.

Table 1: Effect of sowing dates and weed management practices on crop growth at various stages of chickpea.

Treatment	Rate (g a.i. ha^{-1})	Plant height (cm)		Canopy cover (cm)		Branches $plant^{-1}$ at 60 DAS		Nodules $plant^{-1}$		Dry matter accumulation (g $plant^{-1}$)	
		60 DAS	At harvest	60 DAS	At harvest	Primary	Secondary	60 DAS	85 DAS	60 DAS	At harvest
Dates of sowing											
10th November		32.5	61.2	19.4	48.5	4.9	6.8	27.3	29.4	2.9	10.7
25th November		31.4	59.1	18.0	45.5	4.3	6.0	26.3	28.0	2.8	10.6
5th December		30.8	59.1	17.5	45.1	4.3	5.7	26.4	28.9	2.7	10.6
SEm +		0.3	0.1	0.1	0.2	0.2	0.1	0.7	0.4	0.0	0.2
CD (P=0.05)		1.15	0.46	0.3	0.8	NS	0.6	NS	NS	0.1	NS
Weed Management											
Weedy		29.7	57.5	15.8	41.6	4.0	5.7	23.3	25.8	2.5	10.1
Weed free	2 (30 and 60 DAS)	32.7	63.6	19.1	48.3	5.0	6.6	32.6	35.0	3.0	11.2
Pendimethalin	1000 and PRE	31.1	58.9	18.5	46.4	4.3	5.9	24.7	26.8	2.7	10.4
Quizalofop	50 and POST	32.2	60.6	18.7	47.4	4.6	6.6	26.3	27.7	2.9	11.1
Imazethapyr	37.5 and POST	30.3	58.2	18.5	46.3	4.1	5.7	24.4	26.7	2.7	10.1
Pendimethalin fb. Quizalofop	1000+50 PRE+POST	32.5	60.6	18.9	47.7	4.8	6.6	31.3	33.1	2.9	11.2
Pendimethalin fb. Imazethpyr	1000+37.5 PRE+POST	32.3	59.0	18.5	46.5	4.4	6.2	24.8	27.4	2.8	10.4
Pendimethalin fb. Mechanical Weeding (60 DAS)	1000+ 1at 55 DAS	31.8	60.1	18.5	46.5	4.4	6.1	25.7	27.6	2.8	10.6
SEm+		0.68	0.37	0.16	0.33	0.24	0.26	0.64	0.59	0.10	0.26
CD (P=0.05)		1.94	1.05	0.44	0.93	0.70	0.73	1.82	1.70	0.27	0.74

Note: g a.i. ha^{-1} = gram active ingredient per hector**, g $plant^{-1}$ =** Gram per plant**, DAS=** Days after sowing, **fb.=** Followed by

Table 2: Effect of sowing dates and weed management practices on crop phenology of chickpea.

Treatment	Rate (g a.i. ha^{-1})	Germination (Days)	Branching (days)	Flowering (Days)	Pod formation (Days)	Maturity (Days)
Dates of sowing						
10th November		6.8	20.8	78.2	87.8	114.8
25th November		7.0	21.1	78.3	88.6	115.0
5th December		7.8	21.8	78.9	91.3	115.1
SEm ±		0.1	0.1	0.3	0.3	0.2
CD (P=0.05)		0.5	0.5	NS	1.0	NS
Weed Management						
Weedy		8.2	21.8	79.8	88.6	116.2
Weed free	2 (30 and 60 DAS)	6.8	20.7	77.2	88.9	112.4
Pendimethalin	1000 and PRE	7.2	21.1	78.9	88.4	115.9
Quizalofop	50 and POST	7.0	21.6	78.0	89.9	114.9
Imazethapyr	37.5 and POST	7.3	21.7	79.4	89.3	115.0
Pendimethalin fb. Quizalofop	1000+50 PRE+POST	7.0	20.8	77.7	90.0	114.8
Pendimethalin fb. Imazethpyr	1000+37.5 PRE+POST	7.1	21.2	78.1	89.3	115.0
Pendimethalin fb. Mechanical Weeding (60 DAS)	1000+ 1at 55 DAS	7.0	21.2	78.8	89.4	115.3
SEm+		0.22	0.35	0.43	0.40	0.37
CD (P=0.05)		0.63	NS	1.23	NS	1.07

Note: g a.i. ha^{-1} = gram active ingredient per hector**, fb.=** Followed by

Table 3: Effect of sowing dates and weed management practices on yield attributes and yield of chickpea.

Treatment	Rate (g a.i. ha^{-1})	Pods plant^{-1}	Grains pod^{-1}	100-Seed weight	Grain Yield (Kg ha^{-1})	Straw Yield (Kg ha^{-1})	Harvest Index (%)
Dates of sowing							
10th November		41.0	1.7	17.4	1475.2	3353.6	30.55
25th November		38.2	1.3	17.3	1303.6	2988.5	30.37
5th December		33.6	1.1	16.0	1118.0	2529.1	30.65
SEm ±		0.7	0.1	0.1	41.2	80.6	0.5
CD (P=0.05)		2.8	0.2	0.4	162.2	316.6	NS
Weed Management							
Weedy		35.1	1.0	15.4	352.3	989.7	26.25
Weed free	2 (30 and 60 DAS)	40.3	1.7	17.7	1651.6	4165.1	28.39
Pendimethalin	1000 and PRE	36.3	1.2	16.8	1348.3	2712.0	33.21
Quizalofop	50 and POST	39.1	1.6	17.1	1513.5	3312.6	31.36
Imazethapyr	37.5 and POST	36.0	1.2	16.8	1240.2	2651.0	31.87
Pendimethalin fb. Quizalofop	1000+50 PRE+POST	39.1	1.7	17.3	1550.5	3561.5	30.33
Pendimethalin fb. Imazethpyr	1000+37.5 PRE+POST	36.3	1.3	17.1	1354.4	3099.1	30.41
Pendimethalin fb. Mechanical Weeding (60 DAS)	1000+ 1at 55 DAS	38.4	1.3	17.0	1380.5	3165.7	30.37
SEm+		0.84	0.12	0.18	66.17	158.14	0.76
CD (P=0.05)		2.39	0.35	0.53	188.84	451.33	2.16

Note: g a.i. ha^{-1} = gram active ingredient per hector**, Kg ha^{-1} =** Kilogram per hector, **fb.=** Followed by

Table 4: Effect of sowing dates and weed management practices on density (m^{-2}) of different weed species at various stages of chickpea.

Treatment	Rate (g a.i. ha^{-1})	*Melilotus alba*		*Cynodon dactylon*		*Phalaris minor*		*Chenopodium album*		*Medicago hispida*	
		60 DAS	At harvest	60 DAS	At harvest	60 DAS	At harvest	60 DAS	At harvest	60 DAS	At harvest
Dates of sowing											
10th November		22.6	14.6	20.8	15.8	4.3	2.0	4.9	2.0	3.7	0.9
25th November		23.5	16.9	23.0	16.1	4.6	2.2	5.0	2.2	4.0	1.1
5th December		25.4	17.5	23.3	17.0	4.7	2.3	5.1	2.8	4.3	1.3
SEm ±		0.7	0.4	0.9	0.9	0.2	0.2	0.2	0.2	0.2	0.2
CD (P=0.05)		NS	1.5	NS	NS	NS	NS	NS	NS	NS	NS
Weed Management											
Weedy		72.0	31.7	51.6	27.1	12.3	9.8	9.4	6.6	6.7	3.2
Weed free	2 (30 and 60 DAS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pendimethalin	1000 and PRE	23.0	18.0	23.2	18.0	5.1	1.4	10.2	6.4	5.8	2.6
Quizalofop	50 and POST	18.2	14.7	19.7	16.7	3.0	1.1	2.8	0.9	3.0	0.1
Imazethapyr	37.5 and POST	21.6	17.8	22.6	17.7	5.0	1.3	5.6	1.4	5.3	1.2
Pendimethalin fb. Quizalofop	1000+50 PRE+POST	16.9	14.3	18.7	16.6	2.6	1.0	2.4	0.8	2.4	0.0
Pendimethalin fb. Imazethpyr	1000+37.5 PRE+POST	20.3	16.4	21.9	17.6	4.3	1.2	5.1	1.3	4.8	0.9
Pendimethalin fb. Mechanical Weeding (60 DAS)	1000+ 1at 55 DAS	18.2	14.7	21.4	16.9	3.7	1.1	4.6	1.2	4.1	0.9
SEm±		1.21	1.05	1.35	1.16	0.27	0.26	0.26	0.54	0.40	0.31
CD (P=0.05)		3.46	2.99	3.84	3.32	0.78	0.74	0.73	1.54	1.13	0.90

Note: g a.i. ha^{-1} = gram active ingredient per hector, **DAS=** Days after sowing, **fb.=** Followed by

Table 5: Effect of sowing dates and weed management practices on dry weight (g m^{-2}) of different weed species at various stages of chickpea.

Treatment	Rate (g a.i. ha^{-1})	*Melilotus alba*		*Cynodon dactylon*		*Phalaris minor*		*Chenopodium album*		*Medicago hispida*	
		60 DAS	At harvest	60 DAS	At harvest	60 DAS	At harvest	60 DAS	At harvest	60 DAS	At harvest
Dates of sowing											
10th November		8.1	5.1	1.3	0.9	0.118	0.006	2.30	0.92	1.21	0.30
25th November		8.6	5.3	1.4	1.0	0.121	0.025	2.32	1.03	1.37	0.37
5th December		8.8	22.3	1.5	1.0	0.134	0.048	2.33	1.33	1.48	0.46
SEm ±		0.1	9.8	0.1	0.1	0.008	0.054	0.08	0.13	0.04	0.07
CD (P=0.05)		0.4	NS	NS	NS	NS	NS	NS	NS	0.16	NS
Weed Management											
Weedy		27.4	49.9	3.6	1.4	0.340	0.202	4.27	3.05	2.28	1.07
Weed free	2 (30 and 60 DAS)	0.0	0.0	0.0	0.0	0.000	0.000	0.00	0.00	0.00	0.00
Pendimethalin	1000 and PRE	7.9	11.8	1.4	1.1	0.143	0.028	4.65	2.86	2.00	0.88
Quizalofop	50 and POST	6.2	4.9	1.1	1.0	0.092	0.020	1.43	0.42	0.90	0.00
Imazethapyr	37.5 and POST	7.3	5.4	1.4	1.1	0.142	0.027	2.48	0.78	1.88	0.43
Pendimethalin fb. Quizalofop	1000+50 PRE+POST	5.8	4.8	0.9	1.0	0.076	0.012	1.26	0.34	0.80	0.00
Pendimethalin fb. Imazethpyr	1000+37.5 PRE+POST	6.7	5.2	1.3	1.1	0.106	0.026	2.29	0.68	1.61	0.32
Pendimethalin fb. Mechanical Weeding (60 DAS)	1000+ 1at 55 DAS	6.3	5.0	1.2	1.1	0.094	0.024	2.16	0.61	1.35	0.31
SEm±		0.46	15.84	0.16	0.08	0.012	0.015	0.13	0.27	0.14	0.11
CD (P=0.05)		1.30	NS	0.47	0.23	0.034	0.042	0.37	0.78	0.39	0.31

Note: g a.i. ha^{-1} = gram active ingredient per hector, **DAS=** Days after sowing, **fb.=** Followed by

RESULTS AND DISCUSSION

Weeds: The minimum and maximum density of *Melilotus alba, Cynodon dactylon, Phalaris minor, Chenopodium album* and *Medicago hispida* were recorded in 10th November and 5th December-sown crop, respectively. These results are in agreement with the findings of Singh et al. (1999); thereby, recording the minimum and the maximum crop dry weight at 60DAS planted at 10th November and 5th December, respectively. All the herbicide treatments significantly reduced the density of the weeds when compared with weedy check. However, sequential application of Pendimethalin at 1.0 kg a.i. ha^{-1} as pre-emergence followed by Quizalofop 50 g a.i. ha^{-1} as post-emergence recorded lowest density and dry matter accumulation by different weed species in the experimental crop. These result can be discussed in the light of fact that Pendimethalin controlled the germination of initial flushes of weeds and Quizalofop affected the germinated weeds those escape Pendimethalin treatment. Similarly, Pendimethalin followed by mechanical weeding do have less density and weed dry weight at respective stages of observations. These results are supported by the findings of Pooniya *et al.* (2009).

Crop growth: The maximum and the minimum nodules $plant^{-1}$ recorded by crop sown on 10th November and that on 5th December. This might be due to fact that crop sown on 10th November translocated more photosynthesis for nodule development as event from its high dry matter accumulation and it recorded maximum dry weight over later sown crop at 60 DAS and the result was no significant at harvest. Different sowing showed no significant effect on primary branches but showed significant effect on secondary branches $plant^{-1}$ at 60 DAS. The plant height of chickpea was more in Pendimethalin followed by Quizalofop irrespective of the stage of observation which may be due to the better weed control and low weed dry weight. The maximum canopy cover was recorded in weed free treatment. This might be because of no competition with the weeds. Pendimethalin followed by Quizalofop applied at 40 DAS produced significantly more canopy cover than others which may be due to better development of crop plants as evident from the plant height and dry matter production of the crop. Imazethapyr produced lower canopy cover as compared to Pendimethalin followed by Quizalofop treated plots. Dry matter accumulation $plant^{-1}$ increased with the advancement of age of crop and maximum dry matter was recorded at harvest. Weed free and Pendimethalin followed by Quizalofop applied at 40 DAS increased dry matter accumulation $plant^{-1}$ over weedy at harvest. The increase in dry matter might be due to cumulative effect of increased plant height, number of branches $plant^{-1}$, better development of plants and reduced density and dry weight of weeds.

Crop phenology: Germination, branching and pod formation of 10th November-sown crop was earlier than the 25th November and 5th December-sown crop but there was no significant differences had been shown at harvest means maturity was delayed in 10th November-sown crop as compared to later sown crop. The findings are in agreement with the findings of Sharma *et al.* (1994) who reported that significant difference in germination was observed in chickpea when sowing was delayed beyond 25th October due to high temperature. Phenology of crop in terms of germination, flowering and maturity were recorded in minimum days under Pendimethalin followed by Quizalofop. The non significant differences in branching and pod formation can be discussed in light of fact that weeds were under branching and pod formation phase and did not cause any competition to the branching and pod formation seed crop. Later on weeds competed with crop for growth requirements and influenced germination, flowering and maturity.

Yield attributes: The 10th November-sown crop recorded maximum number of pods $plant^{-1}$ and grain pod^{-1} which was significantly higher than 25th November and 5th December- sown crop and significantly higher seed index was also observed under the same date of sowing which was at par with 25th November sown crop. Chickpea grain yield was found significantly highest in weed free. Weedy crop produced lower grain yield as compared to weed free which was attributed to the poor development of yield attributes such as number of pod $plant^{-1}$, grains $pods^{-1}$ and 100-seed weight,

respectively over weed free. Moreover, better development of crop plants also contributed to the increase in grain yield as compared to weedy, which was having the highest weed density and dry weight of weeds. All the herbicides produced significantly lower grain yield as compared to weed free, but proved significantly superior over un-weeded crop (Table 3). Imazethapyr applied at 40 DAS produced significantly less grain and straw yield over rest of the herbicide treatments. This might be due to phytotoxic effect of Imazethapyr on chickpea plant at initial stages of crop growth resulting into stunted growth and reduced plant height and canopy cover.

CONCLUSION

So, it can be concluded that under agro-climatic condition of Bhairahawa, Rupandehi district, Lumbini Province, chickpea crop must be sown on or before 25th November to obtain higher yield and more economic returns. Sequential application of Pendimethalin 1.0kg a.i. ha^{-1} (PRE) followed by Quizalofop 50g a.i. ha^{1} (POST) should be applied for effective weed control and higher yield of chickpea.

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