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Research Article

IMPACT OF LAND CONFIGURATIONS, IRRIGATION SCHEDULING AND WEED MANAGEMENT ON YIELD AND ECONOMICS OF CHICKPEA (*Cicer arietinum* L.)

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Abstract- The field experiment was conducted during *Rabi* 2013-14 at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur to study the impact of land configurations, irrigation scheduling and weed management on yield and economics of chickpea. The treatments comprised three land configurations (Flat bed, Broad bed furrow, Ridge-furrow); three irrigation schedules (Irrigation at branching, Irrigation at pod development, Irrigation at branching and pod development) as main plot treatments and three weed management (Weedy Check, Hand weeding twice at 25 and 50 DAS, Pendimethalin @1.0 kg ha^{-1} as pre emergence) as sub-plot treatments. These treatments were tested in split plot design with three replications. Ridge-furrow method resulted in significantly higher seed yield (1512.33 kg ha^{-1}), gross monetary returns (₹74794 ha^{-1}), net monetary returns (₹43991 ha^{-1}) and benefit: cost ratio (2.40) over flatbed and broad bed furrow. Irrigation at branching and pod development gave appreciably higher seed yield of 1483.33 kg ha^{-1}, gross monetary returns (₹73366 ha^{-1}), net monetary returns (₹42089 ha^{-1}) and benefit: cost ratio (2.31) over rest of the irrigation scheduling. Application of Pendimethal in @ 1.0 kg ha^{-1} PE resulted in 52.17 per cent more seed yield (1592.74 kg ha^{-1}), gross monetary returns (₹79225 ha^{-1}), net monetary returns (₹49504 ha^{-1}) and benefit: cost ratio (2.66) over weedy check. However, hand weeding twice registered in significantly higher seed yield 1719.56 kg ha^{-1} and gross monetary returns (₹84998 ha^{-1}) but had lower B: C ratio.

Keywords- Land configuration, Irrigation scheduling, Weed management, Yield, Economics

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Introduction

Chickpea is the most important *rabi* pulse crop of India. In the World, it occupies an area of 13.54 million hectares with an annual production of 13.31 million metric tons and the average productivity of 971 kg ha^{-1} [1], whereas in India, it occupies an area of 8.52 million hectares with an annual production of 8.83 million metric tons and the average productivity of 1036 kg ha^{-1}. In Madhya Pradesh, it is cultivated in 3.31 million hectares of land with an annual production of 3.81 million metric tons and productivity of 1219 kg ha^{-1} [2], whereas in Jabalpur district, it is cultivated in 0.61 million hectares of land with an annual production of 0.84 million metric tons and productivity of 1376 kg ha^{-1} [3]. Gram seeds, leaves and straw are used in many ways *viz*., as dal, besan, crushed or whole grain, sweet making, green leaves and grain as vegetables. Its seeds are considered to have medicinal effects and are used for blood purification. The seed contains 21 % protein, 61.5 % carbohydrates, and 4.5 % fat and also rich in calcium, iron and niacin. Germinated seeds are recommended to cure scurvy. Soaked seeds and husk are fed to horses and cattle as concentrate and rough ages, respectively. Malic and oxalic acids collected from green leaves are prescribed for intentional disorders. Straw forms an excellent fodder for cattle. Out of the several factors responsible for higher productivity of chickpea land preparation, water and weed management are more crucial and assumes great importance for successful cultivation of chickpea. Land configuration plays a vital role in increasing the crop production. It has recently emerged as the most potential resource conservation technology in Indo-Gangetic plains of North West India under rice–wheat cropping system. Raised bed planting of cereals, pulses and vegetable, on average increased yield by 24.2 % and saving of irrigation water by 31.2 % [4]. Several workers have reported the positive response of seed yield of chickpea to land configuration methods under protective irrigated condition. Chickpea seed yield can be increased by providing suitable land configuration methods [5]. Ridge/Broad Bed Furrow sowing are gaining popularity in case of heavy soils. Flood irrigation in flat bed sowing in heavy soils badly damages the chickpea crop due to water stagnation. If the chickpea is sown on ridge- furrow or broad bed furrow method, less irrigation water is required to crop under water stress conditions and improves seed size and grain yield [6].Weeds are a serious constraint in increasing production and easy harvesting in chickpea. Chickpea is a poor competitor to weeds because of slow growth rate and limited leaf area development at early stage of crop growth and establishment [7]. Keeping the above facts in view, the present investigation was undertaken with the object to find out suitable land configuration, irrigation schedule and weed management for economical production of chickpea.

Materials and Methods

The present experiment was conducted during *Rabi* season of 2013-14 at Research Farm, Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.), which is located at 23^{0}09' N latitude, 79^{0}58' E longitudes and at an altitude of 411 meter mean sea level. Jabalpur lies in the "Kymore plateau and Satpura hills" agro climatic region of Madhya Pradesh. It has the features of sub-tropical climate with hot-dry summer and cool- dry winter. The average maximum temperature during the month of May–June varies between

45.5 to 46.4^{0}C, while the average minimum temperature varies between 8.2 to 8.7^{0}C during December-January, which are the coldest month of the year. The average annual rainfall of this region is about 1350 mm, which is mostly received between June to September, and a little rainfall (75 to 175 mm) in October to May. The average humidity of the tract is about 73 per cent. The experimental field was Sandy clay loam in soil texture. The treatments comprised three land configuration *viz*., Flat bed (M_1), Broad bed furrow (M_2), Ridge-furrow (M_3); three irrigation schedules *viz*., Irrigation at branching (I_1), Irrigation at pod development (I_2), Irrigation at branching and pod development(I_3) as main plot treatments and three weed management *viz*., Weedy Check (W_0), Hand weeding twice at 25 and 50 DAS (W_1), Pendimethalin @1.0 kg ha^{-1} PE (W_2), as sub-plot treatments were laid out in split plot design with three replications. Chickpea variety 'JG 322' was sown on 15th December 2013 at seed rate of 80 kg ha^{-1} with different land configuration methods *viz*., flat bed, broad bed and ridge-furrow and harvested on 15th April 2014. The recommended doses of fertilizer 20: 60: 20 N: P_2O_5: K_2O kg ha^{-1} was applied uniformly. Entire quantities of NPK were applied as basal at the time of sowing.

Harvest index: It is defined as the ratio of economic yield to biological yield and expressed in percentage. The harvest index of chickpea was workout by using the following formula [8],

$$\text{Harvest index}=\frac{\text{Economic yield (kg ha}^{-1})}{\text{Biological yield(kg ha}^{-1})}\times 100$$

Straw: Seed ratio: It is defined as the ratio of straw to seed yield. The Straw: Seed ratio of chickpea was workout by using the following formula,

$$\text{Straw: Seed ratio}=\frac{\text{Straw yield (kg ha}^{-1})}{\text{Seed yield (kg ha}^{-1})}$$

Gross monetary returns (GMR): Based on the prices of output prevailing at the time of harvest, treatment-wise GMR (₹ha^{-1}) was computed.

Net monetary returns (NMR): Based on the current market price of inputs and outputs, the NMR (₹ ha^{-1}) was worked out by using the following formula.

$$\text{Net monetary returns (₹ ha}^{-1})=[\text{Gross monetary returns (₹ ha}^{-1})]-[\text{Total cost of cultivation (₹ ha}^{-1})]$$

Benefit: cost ratio: It was calculated by using the formulae given below:

$$\text{Benefit: cost ratio}=\frac{\text{Gross monetary returns (₹ha}^{-1})}{\text{Total cost of cultivation(₹ ha}^{-1})}$$

Value of Critical differences (CD) was calculated only for those characters, which were found significant at P=0.05 level of significance. The appropriate statistical procedures of 'Split-Plot Design' given by [9] were followed for the data analysis

Results and Discussion

Effect on Seed and Straw yield

Perusal of the data [Table-1] indicates that among the different land configuration methods, ridge-furrow method resulted in significantly higher seed yield (1512.33 kg ha^{-1}) which was 10.82 and 19.78 per cent more in comparison to broad bed furrow and flat-bed methods, respectively. Different land configurations exhibited almost similar trend in straw yield as observed in case of seed yield. This might be due to better porosity and availability of soil moisture which helped in better growth and development of the crop. These similar findings are in collaboration with the results of [10]. Irrigation at branching and pod development gave appreciably higher seed yield of 1483.33 kg ha^{-1}. The increase in seed yield with irrigation at branching and pod development was 11.12 and 14.22 per cent more than that of irrigation at pod development and at branching alone, respectively. Straw yield indicated similar influence due to irrigation levels as noted in seed yield. The higher yield under Irrigation at branching and pod development stage was owing to availability of soil moisture at branching as well as pod development, which enhanced the yield attributes ultimately resulting in higher seed yield. Similar results are also advocated by [11]. Among the different weed control treatments, application of Pendimethalin @ 1.0 kg ha^{-1} as pre emergence resulted in 52.17 per cent more seed yield (1592.74 kg ha^{-1}) over weedy check. However, hand weeding twice registered markedly higher seed yield of 1719.56 kg ha^{-1} being 55.70 per cent more in comparison to control (761.81 kg ha^{-1}).The increase in seed yield due to application of Pendimethalin @ 1.0 kg ha^{-1} or hand weeding twice was attributed to effective control of weeds which helped the crop by enhancing the availability of nutrients and soil moisture which caused enhancement in yield attributes and finally seed yield. These results are in agreement with the findings of [12].

Table-1 *Seed yield, straw yield, harvest index and Straw: Seed ratio as influenced by different treatments*

Treatment	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)	Straw: Seed ratio
Land Configurations				
M_1-Flat Bed	1213.15	2986.99	28.78	2.48
M_2-Broad Bed Furrow	1348.63	3251.44	29.19	2.43
M_3-Ridge-Furrow	1512.33	3575.05	29.61	2.38
SEm±	29.71	72.65	0.07	0.01
CD (p=0.05)	89.07	217.80	0.20	0.02
Irrigation Schedules				
I_1-Irrigation at branching	1272.44	3139.93	28.71	2.49
I_2-Irrigation at pod development	1318.33	3165.39	29.29	2.42
I_3-Irrigation at branching and pod development	1483.33	3508.16	29.57	2.38
SEm±	29.71	72.65	0.07	0.01
CD (p=0.05)	89.07	217.80	0.20	0.02
Weed Management				
W_0-Weedy Check	761.81	1880.67	28.75	2.48
W_1-Hand weeding twice at 25 and 50 DAS	1719.56	4054.06	29.74	2.36
W_2-Pendimethalin @1.0 kg/ha.PE	1592.74	3878.75	29.07	2.44
SEm±	20.93	48.23	0.06	0.01
CD (p=0.05)	60.07	138.46	0.18	0.02

Effect on Harvest index and Straw: Seed ratio

Data presented in [Table-1] indicates that ridge-furrow method was registered statistically significantly higher harvest index (29.61 %) and lowers Straw: Seed ratio (2.38) in comparison to broad bed furrow and flat-bed methods. These similar findings are in collaboration with the results of [10]. Among irrigation schedules, Irrigation at branching and pod development gave appreciably higher harvest index (29.57%)and lower Straw: Seed ratio (2.38) as compared to rest of irrigation schedules. Similar, results are also advocated by [11]. Among the different weed control treatments, hand weeding twice as resulted higher in harvest index (29.74%) and lower Straw: Seed ratio (2.36) over weedy check. These results are

in agreement with the findings of [12].

Effect on economics of the treatments:

Data regarding economics of the treatments presented in [Table-2] indicated that the ridge-furrow method in chickpea had the maximum cost of cultivation (₹30802 ha^{-1}) in comparison to flat-bed and broad bed furrow methods due to special implement required for sowing but gross monetary returns (₹74794 ha^{-1}), net monetary returns (₹43991 ha^{-1}) and B: C ratio (2.40) were recorded higher in ridge-furrow method. Irrigation at branching and pod development increased cost of cultivation by ₹31277 ha^{-1} due to two irrigations gave in the treatment but though the maximum gross monetary returns (₹73366 ha^{-1}) and net monetary returns (₹42089 ha^{-1}) and B: C ratio (2.31).The similar finding is also reported by [13]. Among the different weed control treatments, hand weeding twice increased the cost of cultivation and more gross monetary returns and but not increased so morenet monetary returns due to enhanced labour cost for weed control. Pendimethalin @ 1.0 kg ha^{-1} decreased the cost of cultivation (₹29721 ha^{-1}) and registered the higher gross (₹79225 ha^{-1}) and net monetary returns (₹49504 ha^{-1}) and B: C ratio (2.45) over weedy check. Similar results are advocated by [14].

Table-2 *Economics of chickpea cultivationas influenced by different treatments*

Treatment	Cost of cultivation (₹ ha^{-1})	Gross Monetary Returns (₹ ha^{-1})	Net Monetary Returns (₹ ha^{-1})	Benefit: Cost Ratio
Land Configurations				
M_1-Flat Bed	30552	60474	29921	1.95
M_2-Broad Bed Furrow	30677	66951	36273	2.14
M_3-Ridge-Furrow	30802	74794	43991	2.40
SEm±	--	1476	1476	0.05
CD (p=0.05)	--	4426	4426	0.14
Irrigation Schedules				
I_1-Irrigation at branching	30377	63457	33080	2.05
I_2-Irrigation at pod development	30377	65395	35017	2.12
I_3-Irrigation at branching and pod development	31277	73366	42089	2.31
SEm±	--	1476	1476	0.05
CD (p=0.05)	--	4426	4426	0.14
Weed Management				
W_0-Weedy Check	27656	37995	10340	1.37
W_1-Hand weeding twice at 25 and 50 DAS	34656	84998	50343	2.45
W_2-Pendimethalin @1.0 kg/ha.PE	29721	79225	49504	2.66
SEm±	--	1028	1028	0.03
CD (p=0.05)	--	2951	2951	0.10

Conclusion

Based on the above findings it could be concluded that ridge-furrow method with two irrigations at branching and pod development stages as well as application of Pendimethalin @1.0 kg ha^{-1} as pre emergence results in higher seed yield, gross monetary returns, net monetary returns and benefit: cost ratio under sandy clay loam soil of Jabalpur (M.P.)

Conflict of Interest: None declared

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